NATURE

SATURDAY, MARCH 28, 1931.

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Editorial and Publishing Offices :

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.

No. 3204, Vol. 127]

University Entrance Scholarships for Science.

At the Headmasters' Conference last December the following resolution was passed, with only four dissentients :

"That this Conference regrets the degree of specialisation which the Science Scholarship Examination papers at Oxford and Cambridge demand from candidates, and wishes

(1) that in all Science Scholarship Examination papers the General Paper should be given a definite value, and

(2) that at least some Science Scholarships could be offered for which a less specialised course of Science would be required."

Recent correspondence on this subject in the *Times* points to the existence of an educational problem, but fails to produce any satisfactory solution. Mr. Fletcher, headmaster of Charterhouse and chairman of the Headmasters' Conference, deprecates the fact that boys who cannot afford to go to the university without a scholarship, often the best material at the start, are forced prematurely into an undesirably narrow groove ; and implies that thus the probable future leaders of science are being brought up as "illiterate and premature specialists". He offers no constructive suggestion to remedy the evil, but hopes that university authorities may by his very importunity be urged to take action.

In defence of Oxford, Mr. C. N. Hinshelwood, of Trinity College, points out that in the examination held by a group of nine colleges, candidates must (1) offer at least three subjects selected from chemistry, physics, zoology, botany, mathematics ; (2) take a paper in which are set passages for translation from four languages ; (3) do a general paper, to which a very definite value is attached. His account of the principles observed in making the awards renders it difficult to conceive how the examination could be improved.

From Cambridge, Mr. J. T. Saunders, of Christ's College, champions the educational value of science rightly taught, and directs attention to the importance of personal, as distinct from tutorial, influence in stimulating general culture.

Among other correspondents, Dr. F. A. Bather advocates that future endowers of scholarships should give the money to the schools and not to the colleges ; Mr. Knight, until recently headmaster of Sexey's School, Bruton, urges that the universities should reserve a fair proportion of available scholarships for candidates who have covered a wider curriculum, as indicated in paragraph (2) of the

Conference resolution; Prof. A. V. Hill, admitting the disease and the difficulty of curing it, politely hints that the classical pot is every whit as black as the scientific kettle; and so on.

It is generally admitted that, especially in chemistry and physics, the papers now set are of a more advanced character than was the case, say, twenty years ago. But the improved equipment of school laboratories and the increase in the number of science masters per school render possible, nay, justify, the attainment of a higher standard of work at schools. Moreover, natural science is essentially progressive. The discoveries made during the present century have profoundly modified our ideas both in biology and in physical chemistry, and it is right that the rising generation be taught to view each subject in the light of the most recent knowledge. Probably no school permits its pupils to specialise in any direction, scientific or other, until a school certificate examination has been taken. This examination, though elementary, does at any rate ensure a certain minimum of general education; and by the time a pupil takes it his capacity for profiting intellectually by specialisation in a particular direction ought to be fairly evident.

It must not be forgotten that all minds are not cast in the same mould, and that all do not mature at the same rate. Some there are who, about sixteen years of age, show marked ability in classical and literary subjects and yet are complete failures in natural science. Conversely, there are those who, by sheer perseverance in the uncongenial deserts of most of the compulsory subjects in the school certificate examination, at length reach the promised land and find their *métier* in one or more of the scientific subjects. Similarly, those wide interests which constitute culture make no appeal to some, be they never so temptingly put before them—a silk purse was never yet made from a sow's ear; but why should the community be deprived of the good leather that it is capable of yielding? The boy who is, unfortunately, gifted in only one direction should surely be allowed to pursue it to the full.

It is perhaps a counsel of perfection to urge that school curricula should be so wide as to afford to every pupil the opportunity of sampling many subjects, and thus of finding out where his true interests lie; though the personality of the teacher often goes far towards determining this. Nevertheless, within the limits of the school certificate subjects, it should be possible to ensure logical thinking and ability to express thoughts and to describe facts in clear, concise, grammatical English; nor ought teachers in specialised, post-certificate subjects to permit written work to be presented in slipshod, illiterate form.

There are several ways by which the cultural outlook of specialist pupils may be enlarged: school societies—debating, literary, musical, travel, and the like—all tend to prevent excessive narrowness; while short courses of lectures on, for example, great artists, musical composers, architecture, exploration, and so on, need make no violent inroads into the time-table, and yet serve to awaken interests the existence and quality of which can be tested in the general paper to which the Headmasters' Conference wishes a definite value assigned.

What this value should be is not easy to decide. Good essays in the general paper are known to have determined the award of science scholarships when there was little to choose between the scientific attainments of competing candidates. But can it be maintained that a candidate who is *facile primus* in the science papers should be disqualified from election by a poor performance in the general paper?

Clause (2) of the resolution of the Headmasters' Conference presents practical difficulties. "A less specialised course of Science" presumably connotes at least two subjects of the usual three, biology, chemistry, and physics, taught in schools. Biologists are bound to have some preliminary teaching in both the other subjects; so it would not appear unreasonable to demand of them in scholarship examinations a knowledge of the elements of chemistry and physics. It is, however, almost impossible for boys offering chemistry and physics to include biology in their *répertoire*. Physics, other than elementary, demands considerable mathematical efficiency; hence the boy who selects physics as one of his subjects must make full use of the hours allotted to mathematics. Biology is thus crowded out of his time-table.

So long as competition exists, examiners will be prone to set questions on topics near the upper limit attainable by the candidates concerned; though it is sometimes possible to discriminate between candidates by means of relatively easy questions, allowing wide scope in the quality of the answers. If representatives from the universities and from the Science Masters' Association could agree on reasonably high boundaries beyond which no question is to be set in scholarship examinations for, say, the next ten years, and if the universities would appoint moderators to supervise the papers proposed by college tutors for scholarship examinations in order to secure that the questions lie within the agreed limits, perhaps the Headmasters' Conference would find less to deplore.

Chemistry in Three Dimensions.

Stereochemie. Von Georg Wittig. Pp. xi+388. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1930.) 25 gold marks.

THE centenary of Kekulé's birth was celebrated in September of 1929, and many chemists who were present on that interesting occasion welcomed the opportunity which Prof. Pfeiffer gave them of inspecting those old models with the black ball attached to four metal rods directed towards the corners of a regular tetrahedron. Those were, in fact, the identical models upon which the youthful van 't Hoff had gazed with wonder, and which doubtless contributed in no little measure to the inspiration which the old university town gave him, for van 't Hoff cherished to the end a love for Bonn. "In Leiden", he wrote, "war alles Prosa, die Umgebung, die Stadt, die Menschen. In Bonn, alles Poesie!" During van 't Hoff's sojourn in Bonn in 1872–73, Kekulé had already gathered round him a band of enthusiastic workers, including men like Franchimont, Spring, Wallach, and Zincke, but the independent Dutchman did not display the slightest inclination to join this illustrious circle, and thus, naturally enough, Kekulé lost interest in him. So off to Wurtz and to Paris, but the seed for one of the greatest conceptions in chemistry had fallen on fertile soil.

Since the formulation of the doctrine of the asymmetric carbon atom by van 't Hoff and Le Bel in 1874, the progress of stereochemistry with all its ramifications has been so rapid and so well sustained that it is an impossible task in the brief scope of some 400 pages to give any account of these advances which can be at once comprehensive and adequate. Dr. Wittig has frankly recognised this difficulty. The literature published after 1904—the date of the appearance of Werner's "Lehrbuch der Stereochemie"—is dealt with in much greater detail than is the earlier work, and in order to effect further economy of space, many branches are perforce either omitted altogether or scarcely mentioned at all. Fortunately, an account of the progress of the study of the Walden inversion is given by Walden himself in his "Optische Umkehrerscheinungen", and chemists who are interested in this problem should consult this résumé. Thus, by dealing very briefly with certain fundamental problems, the author has allowed himself ample space for other sections, notably those concerned with co-ordination compounds and with crystal structure. Indeed, the account of Werner's brilliant researches is altogether admirable, and it is written with remarkable clarity. Incidentally, mention is made of that unique optically active compound containing no carbon and having $[M]_{5600}$–47,000°, a high value which should appeal to those chemists who quote molecular rotations.

Dr. Wittig shows too little discrimination in sifting those aspects which are really important from those which are merely trivial. It would be easy to give many examples in support of this criticism, but one may suffice. The introduction of the camphor sulphonic acids for resolving externally compensated bases proved in the hands of Pope to be an experimental contribution of outstanding service. Not only did it enable him to break entirely new ground in the stereochemistry of nitrogen, sulphur, and other elements, but also Werner and many others who followed later would have been seriously incommoded if the application of those camphor acids on the part of the English investigator had not paved the way. The references on pp. 37 and 169 scarcely suggest that Pope's contribution had any value at all. This is one reason why this book should not be placed in the hands of a beginner, who might also miss the romance engendered by a close survey of the earlier history. Why, for example, should that dramatic episode of the conversion of the sceptical Biot by Pasteur be omitted? It is an old story which can be told again and again without losing its charm.

I find throughout Dr. Wittig's book a distinct lack of balance in the whole treatment; the picture is presented all too often out of its proper perspective. For example, in no country more than in Great Britain has the study of optically active compounds been prosecuted with greater zeal, but we look in vain for an adequate recognition of the contributions of those pioneers, Purdie and P. F. Frankland. Purdie's name is not even mentioned, although the resolution of lactic acid by the addition of a nucleus of *d*- or *l*-zinc ammonium lactate to a supersaturated solution of the inactive double salt is an unusual and an elegant method which still remains the most practical one for preparing the optically active lactic acids by the kilogram. Purdie's methods of resolving lactic and alkyloxypropionic acids by alkaloids, as well as Frankland's resolutions of glyceric acid, are models of exact experimenting which, even in these days of hurried publication, could be read and imitated with very great advantage by those who wish to obtain their substances in a condition of optical purity. Nor is there any reference to those experiments on optically active esters which led to the discovery of the silver oxide

method of methylation, which has proved its value (in the hands of Irvine and others) in the chemistry of carbohydrates. Again, less than justice is done to Frankland's comprehensive work on the connexion between optical activity and chemical constitution, and to the work of his pupils, Patterson and Pickard, in the same field.

It is a matter of some regret that Dr. Wittig has, for lack of space, so little to tell us about the application of stereochemical ideas to enzymatic actions. The reader will, therefore, have to go elsewhere if he wishes information on work such as that of Neuberg, for example. We miss a reference to the ingenious experiments on asymmetric reduction and dismutation, and on the formation of phenylacetyl carbinol by the addition of benzaldehyde to a sugar in the process of undergoing fermentation. Whether the equation

$$C_6H_5.CHO + CH_3.CHO = C_6H_5.CH(OH).CO.CH_3$$

can be accepted for the latter action is a matter for debate, but in any event the asymmetric formation of the lævorotatory ketol by the enzyme carboligase is an observation of striking originality, and one which emphatically should find a place in every modern text-book of stereochemistry.

A few mistakes have been noticed; for example, on p. 21 *Bacillus œthalticus* should be *Bacillus ethaceticus*, and on p. 63 $C_{10}H_9$ should be $C_{10}H_{19}$. The scheme at the top of p. 53 is incomplete, the conversion of the amino-alcohol into the ketone not being indicated, whilst the real point of interest, namely, the retention of optical activity during the semipinacolinic changes from the amino-alcohol and the glycol, is missed altogether. The asymmetric synthesis of mandelic acid was never effected as described on p. 40. The statement on p. 169 that Le Bel obtained the optically active methyl-ethyl-propyl-isobutyl ammonium chloride is incorrect; the first quaternary compound of this type was prepared by Pope in 1899.

In the index and throughout the text the names of authors should be revised; designations such as B. Cohen, O. Forster, A. Guye, F. Landolt, H. Perkin, S. Patterson, F. Frankland, etc., enable us to recognise the authors, but they have a strange look!

In spite of some defects, this book can be commended most cordially to those who are not actually beginners in the study of stereochemistry. Dr. Wittig has given us by far the best account of this subject which has been published within the past twenty-five years, and we ought to be very grateful to him.

ALEX. MCKENZIE.

Star Clusters and the Galaxy.

Star Clusters. By Harlow Shapley. (Harvard Observatory Monographs, No. 2.) Pp. xi + 276 + 3 plates. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1930.) 15*s*.

IN 1915–18, Dr. Shapley published a remarkable series of researches on globular clusters which brought these remote objects into the forefront of astronomical interest. His results indicated an extension of the flattened system of the galaxy about ten times greater than had previously been adopted. This was the beginning of a phase in astronomy which its critics might describe as megalomania. The same method has since been applied to the still more distant spiral nebulæ, and these have tended to displace the globular clusters in their appeal to our imagination. From the observational point of view, however, there is no comparison between the stage of advancement of the two subjects. As regards the spirals, our systematic knowledge is summed up in a fairly trustworthy calculation of the size and distance of three or four of the nearest of them, a guess at the distances of the remainder, and the astonishing fact that almost without exception they are running away; as regards the star clusters, we have before us Shapley's monograph, closely packed with statistics and individual studies, with a wealth of problems and deductions which interact with and illuminate our knowledge of the stars in our immediate neighbourhood.

In the bibliography at the end of the book, Shapley's share amounts to 150 papers. It was time, therefore, that he should make this attempt to consolidate the gains to knowledge during fifteen years of assiduous research. Primarily the book is a mine of information where we may find set forth the latest position with regard to the innumerable problems which the study of star clusters has provoked. One of the most intriguing features of the work, recognised at the outset, has been that in some respects our knowledge of the distribution and statistics of stars in these systems 10,000-50,000 parsecs away may be much more advanced than our knowledge of the stars at less than 100 parsecs distance. The reason is that the distances of the nearer stars are found individually with great labour and uncertainty, whereas in observing a globular cluster a single determination of distance applies to the whole system. The principal method of finding the distance is by measuring the apparent magnitude of the Cepheid variables

contained in the cluster; comparing the apparent magnitude with the known absolute magnitude of a Cepheid of the same period, the distance is obtained immediately, provided that absorption of light in interstellar space in inappreciable. The method was first used by Hertzsprung to find the distance of the lesser Magellanic Cloud. Shapley has found the distances of twenty out of the ninety known globular clusters in this way. Distances of the remainder are estimated by more doubtful procedure. Shapley uses distances determined by either method promiscuously. We think this is unfortunate; for even if the validity of the less direct methods is admitted, it is clear from his own diagrams that the distance obtained for an individual cluster is very rough, and its value is mainly statistical.

The assumption that the light of the globular cluster suffers no important absorption in reaching us is probably legitimate; but the monograph may give an undue impression of the strength of the evidence. Actually the main evidence for transparency (none too strong) is outside the scope of the monograph, being based on our general knowledge of the density and state of the interstellar cloud. Shapley showed that the light coming from star clusters is not reddened by scattering, and thus settled a long outstanding question; but with our present knowledge, both observational and theoretical, that interstellar matter is ionised, we cannot infer absence of absorption from absence of reddening. In short, Shapley's observational fact (absence of reddening) is countered by another observational fact (existence of ionisation) and the problem reverts mainly to theoretical investigation. Further, we know that about two per cent of the sky is covered with opaque matter; and although there appears to be in general a rather sharp transition from complete opacity to nearly perfect transparency, it will be fortunate if all the ninety clusters escape the transition zones.

There is a startling heading to § 51, "A Theoretical Period-Luminosity Relation for Galactic Cepheids". There is a theoretical period-density relation described elsewhere in the book, but hitherto theory has been baffled to find any explanation of the period-luminosity curve, which is a quite independent correlation. On examination, we find that the heading has no real justification, and the section deals with the relation of the period-luminosity curve to another equally empirical curve; in fact, the argument has gone round the circle, since the data embodied in these two empirical curves were used to verify the original period-density relation. The comparison of "observed and theoretical period-luminosity relations" on p. 148 is an alternative way of presenting the more usual comparison of the observed and theoretical period-density relations.

Shapley concludes that the minimum diameter of the galactic system is 70 kiloparsecs, with a thickness about one-tenth as great. Our distance from the centre is about 16 kiloparsecs; this is in satisfactory accordance with estimates ranging round about 10 kiloparsecs based on the phenomenon of galactic rotation. I see no escape from dimensions of this order, yet it raises a difficult question when we come to compare the galactic system with the spiral nebulæ. I think it was Shapley who remarked that if the spirals are 'island universes' our galaxy is a 'continent'. The discrepancy in size between our galaxy and the external galaxies cannot be attributed to errors in the determination of the distances, for the same method is used for both and a systematic error would expand or contract them equally. If absorption of light in space is appreciable, the discrepancy becomes still greater.

Shapley now proposes the view that our system is not a single spiral but comparable with the clusters of spirals in Coma-Virgo and in Ursa Major; this reverses the difficulty, for their dimensions appear to be much larger than those of the galaxy. If we accept this view, we have to disregard the evidence of galactic rotation; the observed rotation is of differential type which would quickly shear any individual sub-system, and it cannot be interpreted as rotation of a number of separate star-clouds round a common centre. We can only wait for further light on this perplexing problem.

A. S. EDDINGTON.

Biology and Human Life.

The Science of Life. By H. G. Wells, Julian Huxley and G. P. Wells. Pp. xvi + 896. (London, Toronto, Melbourne and Sydney: Cassell and Co., Ltd., 1931.) 21*s.* net.

THIS is in several ways a remarkable book, as its authorship would lead us to expect, for it gives us in one volume a competent comprehensive survey of the whole of biology—physiological, morphological, embryological, and evolutionary; it is written so that it can be 'understanded of the people' and with a sparkle that engages the attention; and it is one of the few books, heralded by Sir Richard Gregory's "Discovery", which make the reader feel that science is not only for illumination,

but also for "the relief of man's estate", as Bacon phrased it. If, as we believe, mankind is at the dawn of a new era—the biological era, when an all-round appeal will be made to the biological sciences, as already to the physical, for guidance in the control of human life—then the big book of Wells, Huxley, and Wells will come to be regarded as an instalment of the relevant 'Law and Prophets'. Along with biology, we are, of course, including psychology, for these two sciences are becoming almost as inseparable as chemistry and physics. No doubt the last scientific word will be with sociology; but that science, though born two millennia ago, has not yet come of age.

It may be said that the appeal to biology began very long ago when the early patients sought the aid of the early physicians; but this was an appeal to an art rather than to a science. For, while many of the physicians, from Hippocrates and Galen onwards, were biologically-minded in a high degree, biology is a modern science and a widespread appeal to biology as a science is still incipient. The recent establishment of a professorship of social biology in the University of London is a natural supplement to a eugenics laboratory, both expressing a movement of which Galton and Pasteur were pioneers. Thus, while we appreciate "The Science of Life" for its wide reach, its educative lucidity, its fair-mindedness, its freshness of presentation, its arresting figures, and so on, we appreciate it most because the authors have had the courage of their convictions and have not hesitated to proclaim, as their particular gospel, that the utilisation of biological knowledge can do much to save man amid his sea of troubles. We do not mean that this book stands alone in this respect; but it is perhaps the largest comprehensive treatise in which 'biology for life' is a dominant note. Cowdry's "Human Biology and Racial Welfare" (1930) is, to our thinking, a fine collection of specialised propagandist tracts; but the book before us is a treatise on biology, written primarily for the scientific instruction of the people, yet ever sounding the note of practical applicability. It would have pleased T. H. Huxley, who was so clearly convinced of the indispensableness of applying science to life, declaring "that there is no alleviation for the sufferings of mankind except veracity of thought and of action, and the resolute facing of the world as it is". The same idea was finely expressed in a convincing address on Jan. 23 last by Sir Walter Morley Fletcher, which ended with the prophetic sentence "that we can find safety and progress only in proportion as we bring into our methods of statecraft the guidance of biological truth".

It is time, however, to give some indication of the scope of this big book; and that is not difficult, for there is a progressive plan. It begins, physiologically, with the living body; it surveys, morphologically, the forms or patterns of life; it insists that the key to intelligibility is the concept of evolution; it discusses the factors in individual development and in racial history (ontogeny and phylogeny); it sketches the ascent of life throughout the ages, the adventures and achievements of the ever-changing Proteus. Then the book begins again, as it were, from the vantage-ground it has gained, and envisages the pageant and drama of life—a fine introduction to ecology. But the drama has its tragic side and this leads to a consideration of disease and the present very chequered health of *Homo sapiens*, who so often belies his specific name. But the activities, the ascent, the adventure, and the drama of life have all their subjective aspect, as real as the objective, though more elusive, and the eighth book of the treatise deals with behaviour, feeling, and thought, leading on to a tentative monistic theory (not so far from the ancient hylozoism!)—the conception of "a single universal world-stuff with both material and mental aspects, of which, so far as we know, life is the crowning elaboration, and human thought, feeling, and willing the highest expression yet attained". The concluding 'Book' deals with the biology of man, and, with a bow to sociology, ends on a melioristic note—"Life under Control".

"The Science of Life" rather disarms criticism by its frankness and sincerity and by its freedom from dogma. Thus, in discussing the transscientific question of purpose in or behind evolution, the authors state (1) the view "of Bergson and Shaw" that organisms work out their own evolution purposively, if not even purposefully; and (2) "the Creationism-up-to-date" of some modernist theologians, that the world of life is the realisation of a divine purpose, which was dynamically embodied in the original institution of the order of Nature. When the reader has got these post-Paleyian views before him as clearly as may be, he is told that "The Science of Life" must say "No" to the first theory, and cannot say "Yes" or "No" to the second. Personally, we are not inclined to be bluffed by a too abstract science, as if it were the only pathway towards truth; but we must admit that the authors occupy a clear-headed and reasonable position—that biology, as biology, has no pronouncement to make on the

validity of the philosophical or religious concept of a purpose behind evolution.

Though the book runs to nearly 900 pages, that is not much for an appreciation of the whole gamut of life. So we are not inclined to say that there should have been more about enzymes and less about the humorous "Margery" and the teleplasm she produces from her mouth. We are sure that the authors must have thought out very carefully what seemed to them the best utilisation of the available space; and their restraint, relaxed just a little perhaps for "Margery", is admirable.

In reading this remarkably successful presentation of the essentials of biology, our pleasure has been occasionally interrupted by finding a crumpled roseleaf; but it is in no carping mood that we give just a few illustrations. "The Science of Life" is certainly not an apsychic biology, yet why does it insist that the body is a machine, and elaborate a comparison which has eventually to be withdrawn as inadequate? Similarly with the use of the word 'mechanism' for the nervous system and the like. The authors are all right, but will their readers be? If biologists say 'machine' often enough, people will begin to believe that they mean what they say. In this particular case, we think that would be a pity, for we agree with the authors that an organism is more than mechanism.

A larger crumpled roseleaf is the picture of random variations and blind selection. No doubt there are saving clauses and corrective illustrations, but some readers will be apt to relapse to the old nightmare view of evolution as a chapter of accidents, which it certainly is not. For many variations are orthogenic; and many are obviously congruent with the already established organic architecture and metabolic routine. Many express themselves in accordance with laws of growth and conditions of organic stability. How many plant variations in the present (and presumably in the irrecoverable past) are shortenings or elongations of the vegetative or floral axis! Similarly, many animal variations are shortenings-down or lengthenings-out of particular arcs on the general life-curve or trajectory. And so on at great length, for the authors know well that a very strong case can be made out for the frequency of definiteness in variation.

Then as to natural selection, it is inadequately summed up in such words as "automatic" and "blind". How often the organism tries to play its hand of hereditary cards, endeavouring after well-being. It is often automatically selected, but it often deliberately selects. Many an able-minded bird or mammal is a factor in its own evolution, though it has no prevision of more than an immediate goal. Again, the general reader requires to be told that the everyday natural selection of nuance variations, though in a sense "blind", is a sifting in relation to an already established *systema Naturæ* of intricate and stabilised inter-relations.

Then again, while we agree with a useful passage on the seamy side of evolution, which certainly includes, as Ray Lankester so well insisted, its degenerations and retrogressions as well as its advances and achievements, we cannot agree with the statement that "we find throughout the rest of life parallels to the diseases that haunt our own". On the contrary, we are prepared to defend the thesis that wild Nature (that is, apart from man's interference) is characteristically marked by exuberant positive health, while in civilised society diseases are rife and sub-health is becoming almost normal!

But enough of these minor criticisms, for we welcome the book with heartiness. It is an achievement of popular exposition in the best sense (and many professional biologists would do well to read it); it is written with learning and lucidity, and permeated with the idea of evolution, including a human evolution which will continue the more rapidly the more it is inspired by the science of life.

Our Bookshelf.

Reports of the Progress of Chemistry. Issued by the Society of Chemical Industry. Vol. 15, 1930. Pp. 758. (London: Society of Chemical Industry, 1931.) 7*s*. 6*d*. to members; 12*s*. 6*d*. to others.

COMMONPLACE as the phrase has become, of this series of reports it may, and indeed should, be said that no chemical library ought to be without it. The flood of literature which descends upon students and practitioners of chemistry grows ever greater, and a correspondingly warmer welcome is given to authoritative surveys. The annual report on the progress of applied chemistry during 1930 is invested with added value in respect of its early publication, for it has been made available six weeks earlier than the corresponding date of publication last year.

Applied chemistry is surveyed in twenty-five chapters. The following are by the same contributors as for 1929: General, plant, and machinery (R. Edgeworth-Johnstone); mineral oils (A. E. Dunstan); fibres, textiles, cellulose, and paper (J. C. Withers); iron and steel (C. O. Bannister); non-ferrous metals (A. R. Powell); electro-chemical and electro-metallurgical industries (H. T. S. Britton and [1930] R. A. Robinson); soils and fertilisers (E. M. Crowther); sugars, starches, and gums (L. Eynon and J. H. Lane); fermentation

industries (H. L. Hind and F. E. Day); foods (L. H. Lampitt); fine chemicals and medicinal substances (E. Stedman). Other sections are: fuel (H. J. Hodsman and A. Kay); gas, carbonisation, tar, and tar products (J. Macleod and T. A. Wilson); colouring matters and dyes (L. J. Hooley); bleaching, dyeing, printing, and finishing (A. J. Hall); acids, alkalis, and salts (P. Parrish and F. C. Snelling); glass (M. Parkin); refractories, ceramics, and cements (J. H. Chesters and W. J. Rees); oils, fats, and waxes (H. M. Langton); paints, pigments, varnishes, and resins (G. C. Attfield, J. O. Cutter, L. R. Hickson, and H. Causer); rubber (T. L. Garner); leather and glue (R. H. Marriott and H. Phillips); sanitation and water purification (A. Parker); photographic materials and processes (A. Batley and E. E. Jelley); explosives (J. Weir). Consideration of essential oils is deferred until next year.

There is much information of interest to the general scientific reader; for example, it is recorded that the price of platinum is now below that ruling in 1914, that the extraction of rhenium, rarest of metals, is being operated commercially in Germany, and that the 'talkies' have stimulated research on photographic emulsions. The chapter on sanitation and water purification deserves special commendation, for although the general standard of the reports is high, some tend more than others to become an expanded list of references. It could be wished, too, that every reporter would survey work which, although of obvious industrial importance, has been classified for purposes of abstract publication as 'pure' chemistry. A. A. E.

Von Zahlen und Figuren: Proben mathematischen Denkens für Liebhaber der Mathematik. Von Prof. Hans Rademacher und Prof. Otto Toeplitz. Pp. vi+164. (Berlin: Julius Springer, 1930.) 9·60 gold marks.

IT has been rightly said that the high walls built up round mathematics by the signs of integration and summation, cause mathematics to be a permanent mystery for the average thinking person. It is true that a thorough insight into higher mathematics requires special training; yet within these abstruse theories, there must be some parts and some examples, at least, which, properly explained, could enable non-experts to peep through the complex texture of mathematics, and derive thereby some measure of enjoyment. This is the spirit which underlies the little work under notice. Although this book will teach nothing new to mathematicians, it will be found most interesting and helpful by those who are interested in mathematics. Without using anything but logic and the most elementary notations, the authors are able to guide one through the mysteries of the prime numbers, of incommensurable lines and irrational numbers, the theory of aggregates and the paradoxes of transfinite numbers, the doctrines of the polyhedra and the measurement of the circle. Although their exposition is based on mathematical facts, the authors lay more stress on the general form and method of the questions treated; while occasional historical remarks add to their interest. Thus, instead of showing the pragmatical aspects of mathematics, or their philosophical importance, the book emphasises the internal and structural characteristics of pure mathematics. The student of logic, in particular, will find in this very able book an ample field for his speculations. T. G.

Synthèses et catalyses industrielles: fabrications minérales. Par Prof. Paul Pascal. Deuxième édition. Pp. vi+456. (Paris: Hermann et Cie, 1930.) 70 francs.

PROF. PASCAL'S book is divided approximately into two parts, the first dealing with nitrogen compounds and the utilisation of atmospheric nitrogen and the second with sulphuric acid. The treatment is detailed and the theory of the processes receives special attention, so that the book is particularly useful in supplementing the more technical treatises. A very brief treatment of hydrochloric acid is given, in which the modern synthetic process receives most attention. The references to the literature are very incomplete, and many important special treatises which could be consulted, in amplification of the various sections, are not mentioned.

Although the author begins with an account of the "Nitrogen Problem", this is somewhat out-of-date, since it does not make clear that the real nitrogen problem at the present day is an economic one. There is now no possibility of a shortage of fixed nitrogen; the problem is how to sell it. Every country is, or shortly will be, self-supporting, and, as the newer processes are installed, the competition with the older will become more and more acute. The trouble will increase as time goes on and the economic difficulties of over-production, which were considered visionary during the War, will become more and more menacing.

Some Dogmas of Religion. By Dr. John McTaggart Ellis McTaggart. Pp. lii+299. (London: Edward Arnold and Co., 1930.) 6*s*. net.

MESSRS. Edward Arnold and Co. have done a valuable service in issuing a new and cheaper edition of the late Dr. Ellis McTaggart's famous book, with a delightful introduction by Dr. C. D. Broad. "Some Dogmas of Religion" has been long out of print (it was first published in 1906) and second-hand copies have been difficult to find and expensive to buy. Of this work Dr. Broad says: "In many respects it is a model of popular philosophical writing. It presupposes no knowledge of philosophy; it is written with admirable clarity, and abounds with apt and amusing illustrations; and it deals with problems which have interested almost all intelligent men in all ages." It was McTaggart who said that the man who has no religion cannot have a bad one; and it was he who expressed the hope that "a time may come when metaphysics may attain the same certainty in a higher sphere which is now often reached by science in a lower sphere". It is well known that McTaggart managed to combine atheism with a belief in immortality and the Church of England. But he was what has become more rare nowadays: he was a serious thinker.

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.*]

Formation of Methyl Alcohol by the Direct Oxidation of Methane.

THE isolation and identification of the primary oxidation product of a hydrocarbon is so crucially important from the point of view of the theory of hydrocarbon combustion that no effort has been spared to overcome the experimental difficulties involved. For, although there is considerable agreement that the main course of the oxidation proceeds in accordance with the hydroxylation theory, during recent years there has been some controversy as to whether the *initial* product is an hydroxylated molecule or a peroxide.

Hitherto the cumulative weight of evidence, both direct and indirect, has been much more in favour of the initial formation of an hydroxylated molecule rather than that of a peroxide. Thus the initial formation of ethyl alcohol by the interaction of ethane and ozonised oxygen at 100° C., the results of recent studies of the slow oxidation of ethane, the formation of acetaldehyde (by intramolecular change from vinyl alcohol) during the initial stages of the slow combustion of ethylene, and what is known concerning the explosive combustion of methane at high initial pressures, have all pointed unmistakably in that direction. Nevertheless, until recently, all efforts to isolate the corresponding alcohol from the initial products of the slow interaction of one of the simpler paraffins with oxygen have been frustrated, apparently because under ordinary conditions the further oxidation of such an alcohol to the di-hydroxy stage occurs so rapidly. Hence upholders of the hydroxylation theory have always postulated an initial 'non-stop run' through the mono-hydroxy to the di-hydroxy stage.

Since the publication, in November last, of the results of a reinvestigation by Mr. S. G. Hill and myself of the slow combustion of ethane (*Proc. Roy. Soc.*, A, 129, p. 434), which showed that the initial product was not a peroxide but either ethyl alcohol or some less oxygenated body, Dr. D. M. Newitt and Mr. A. E. Haffner have succeeded in obtaining substantial quantities of methyl alcohol by the direct interaction of oxygen and methane at temperatures of 360° and pressures of about 100 atmospheres. Under such conditions, and using a mixture initially containing methane and oxygen in the ratio 9 : 1, interaction was complete in a few minutes; about 17 per cent of the methane burnt was recovered from the products as methyl alcohol, another 0·6 per cent as formaldehyde, and the remainder as oxides of carbon and steam. No hydrogen was liberated, and not even a trace of peroxide formed. The methyl alcohol formed was isolated and identified by converting it into both methyl salicylate ('oil of wintergreen') and methyl *p*-nitro-benzoate (m.p. 95°), and it was estimated as methyl nitrite. A full account of these very important experiments will be published in due course by Dr. Newitt and Mr. Haffner, who are to be congratulated on having thus shown conclusively that the slow oxidation of methane proceeds throughout in accordance with the hydroxylation theory.

WILLIAM A. BONE.
Imperial College of Science and Technology,
London, S.W.7, Mar. 21.

Fine Structure in the Hydrogen Band Lines.

WE have recently had an opportunity of examining the spectrum of H_2 in a large Hilger quartz spectrograph crossed by a reflection echelon. The method, of which an account by one of us (W. E. W.) is being prepared for publication elsewhere, gives a record of the structure of all the lines of fair intensity. So far we have only had time to examine a small number of typical lines, but the results are very interesting. The alternate strong lines of two typical bands which end on the $2p\ ^3\Pi_{ab}$ levels are all found to be double with the weaker component on the long wave-length side. (No description of the bands ending on the $2p\ ^3\Pi$ levels has yet been published, but an account of these band systems by Richardson and Davidson has been communicated to the Royal Society.) For example, in the 0—0 band of $3d\ ^3\Sigma$—$2p\ ^3\Pi$ we find that the $Q1$ line 5931·368 is definitely double, the components having an intensity ratio of about 3 to 1 and a separation $\Delta\nu$ about 0·21 wave number. $Q3 = 6002{\cdot}816$ is an incompletely resolved doublet with $\Delta\nu$ about 0·17. $R2 = 5938{\cdot}620$ is an unresolved doublet with $\Delta\nu$ about 0·11. $R4 = 5982{\cdot}561$ is not a simple line, but it is too weak and hazy to estimate the separation. In the 1—1 band of the same system $Q1 = 6021{\cdot}273$ is a very clear doublet with intensity ratio about 5 to 3 and $\Delta\nu$ about 0·21. $R2 = 6027{\cdot}977$ is an unresolved doublet with $\Delta\nu$ about 0·08.

We can compare the foregoing with typical lines of the 0—0 band of the *a* system $3p\ ^3\Pi_{ab}$—$2s\ ^3\Sigma$.[1] $Q1$ and $R0$ appear to have a very close satellite on the *short* wave-length side of the main line. $Q2$, $Q3$, $R2$, $R3$ are fairly sharp lines, but not so sharp as some lines in the spectrum. $R1$ is a doublet with the weaker component on the *short* wave-length side, intensity ratio about 3 to 10, and $\Delta\nu$ about 0·22. Unless this $R1$ is a blend with an unclassified line, these results mean that $3p\ ^3\Pi_b$ is complex with the stronger level lower (as in $2p\ ^3\Pi_{ab}$) and so is $2s\ ^3\Sigma$ but with the weaker level lower. The comparative magnitudes of the triplets (which we have only resolved into doublets) run $2p\ ^3\Pi_{ab} > 3p\ ^3\Pi_b \approx 2s\ ^3\Sigma > 3p\ ^3\Pi_a$. If $R1$ is a blend, the width of $2p\ ^3\Pi$ is much greater than that of the other levels, but the remaining conclusions would require reconsideration.

On the other hand, typical lines of the singlet systems such as 4856·553 ($= 0$—$1\ P5$ of $3d\ ^1\Pi_a$—$2p\ ^1\Sigma$), 4873·010 ($= 0$—$1\ Q3$ of $3d\ ^1\Pi_b$—$2p\ ^1\Sigma$), and 4822·943 ($= 2$—$4\ R3$ of $3d\ ^1\Sigma$—$2p\ ^1\Sigma$) are sharp lines with no evidence of structure beyond temperature breadth and are definitely sharper than any of the lines so far considered. This is not due to some accidental circumstance connected with the different region of the spectrum in which they lie. For example, 4849·303, which is 0—0 $R1$ of 4 (or 3)$p\ ^3\Sigma$—$2s\ ^3\Sigma$, and lies near these lines, is complex and asymmetric with the bulk of the energy not in the centre. 4838·242, which is $R3$ of the same band, is similar to the $R1$ line except that it is weaker.

The measurements given above are of a preliminary character. We have a plate which looks better than the one on which they were made and we hope to improve on them. The limit of our resolution is set by the natural temperature width of the lines; it is nowhere near the limit of the instruments employed. We cooled our discharge tube in liquid air. No doubt better results could be got with liquid hydrogen, but this is not available.

These observations firmly establish the correlation between the spectrum of molecular hydrogen and that of atomic helium.

O. W. RICHARDSON.
W. E. WILLIAMS.
King's College, Strand, W.C.2, Mar. 12.

[1] Richardson and Das, *Proc. Roy. Soc.*, A, vol. 122, p. 688; 1929.

The Meaning of Existence.

WHAT Sir James Jeans says (NATURE, Feb. 28, p. 304) is, of course, quite true; but it scarcely answers Prof. Muirhead's question. May I try to explain what existence means in physics?

Primarily, it means the truth of some law having the form which defines a substance or object. To say that silver exists is simply to declare that it is possible to demonstrate experimentally the association of the 'properties of silver', a certain density, melting point, and so on. No serious person during the last fifty years has believed that the ether exists in this sense.

Secondarily, it means the truth of some theory. A theory is not true unless (*a*) true laws can be deduced from it and (*b*) its hypothesis is intrinsically plausible. This intrinsic plausibility is often derived from analogy with laws; if the laws from which it is derived are of the aforesaid form, the theory implies the existence of something. Kelvin held that the ether exists because he believed in a theory the hypothesis of which had an intrinsic plausibility arising from an analogy with the laws describing the oscillations of a continuous medium. That theory is now known to be false on ground (*a*); Kelvin's ether, therefore, does not exist. But another theory has been put forward the hypothesis of which is a set of equations having an imperfect analogy with those describing the geometrical laws of space—which might be occupied by a continuous medium. This theory is certainly true on ground (*a*). Some of us (including Sir James Jeans, I think) do not feel that the theory derives any intrinsic plausibility from this loose and indirect connexion with a continuous medium; we therefore reject the existence of the ether on ground (*b*). Others feel that it does; the idea of a continuous medium filling all space helps them to understand and believe relativity; for them both (*a*) and (*b*) are satisfied, and they hold that the ether exists. Since the difference is one of personal taste (not, as Eddington suggests, of words), there is no way of deciding between us.

Two comments may be added. (1) Physicists do not apply these criteria of existence consciously; they can be brought to light only by examining what physicists do believe to exist. That is inevitable; for physics does not arrive at truth by formal reasoning based on fixed principles; it employs reasoning only to expound and to co-ordinate conclusions reached by some more instinctive process. (2) Existence in the physical sense has, of course, no meaning outside the region of experience that can be analysed into laws; and it is hopeless to explain what physical existence means to anyone to whom a law is not a primary and unanalysable conception. NORMAN R. CAMPBELL.

155 Hagden Lane,
Watford, Herts, Mar. 1.

I HAVE to thank Sir James Jeans for his courteous reception (NATURE, Feb. 28, p. 304) of my recent communication in these columns. I had no intention of starting metaphysical hares in this field, but merely to express my agreement with him in holding that physical discussions are also apt to have their hares unless we begin with definitions of our terms. His very interesting letter brings this home from the side of the contrast between the physicist of forty years ago with his assumption of "a vast independent universe of concrete machinery, unthinkingly and unconsciously accepted as his universe of discourse", and the scientific worker of to-day, who finds his universe of discourse in "a phenomenal universe as apprehended by his brain". Though I should perhaps use other terms for the latter, I think that this well describes the change in the intellectual atmosphere brought about by recent developments in physics, to which I began by alluding in my former letter. The "vast independent universe of concrete machinery" had not only established itself in the mind of the physicist of those days as independent, but also it was endangering the independence of all other universes by reducing them to appanages of itself, as the only reality, containing the "promise and potency" of all other forms of existence.

Since then, not only have other universes (for example, those of mind and its creations in art, law and morality, science itself, to mention no others) staked out claims of their own in a lateral direction, but also physics itself, in extending its work vertically, has struck on a world to which the old conception of "concrete machinery" seems to be no longer applicable and the method of behaviour of which has to be expressed in quite other terms. How this world is to be co-ordinated with that of concrete machinery is, I suppose, one of the questions that at present occupy and are likely long to occupy the foremost scientific workers.

What Sir James Jeans, among others, as I understand him, has suggested, is the paradoxical conclusion that, in thus deepening the view of its own universe, physics has revealed analogies between it and other universes that *prima facie* belong to an altogether different order, and has thus opened up the possibility of a synthesis founded, not on their subordination to mechanical conceptions, but on the free right of each to develop its own underlying assumptions in a republic of inter-related universes.

If there is any truth in this view, we may thank discussions like that out of which this correspondence rose for bringing it more clearly to light. Its precise bearing on the particular point at issue is another matter. My own amateurish suggestion was not exactly that which Sir James Jeans attributes to me. I mentioned the world of values as a conspicuous example of a universe of discourse beyond the field of "pointer readings"; but "values" have enough to answer for without being loaded with the problem of ether. Ether might be shown to serve a purpose, to have, if we like, explanatory value, and that, I suppose, is what its advocates try to show; but on that I am not competent to express an opinion.

If I may restate it in other terms, perhaps less ambiguous than those I used, what I meant to suggest was, *first*, that whatever can be said for the existence of such an entity, it seems to be becoming more and more obvious that it does not fall within the universe defined as "that which is continuous with the felt, waking body"; and *secondly*, that the insistence upon it nevertheless as a real entity may not be unconnected with what Meyerson calls the "natural metaphysic" of the human mind which prompts it to seek for substantiality in what it takes as "given". For, in spite of what writers like Whitehead are saying in criticism of the old category of substance, we may drive it out with a fork but it will always recur; and if there is no place for it in the universe of mathematical physics, there will always be those who will try to find one elsewhere.

J. H. MUIRHEAD.

The Use of Covers on Lambs in Biological Work on Wool.

MY fellow-workers on wool in the northern hemisphere will soon be welcoming a crop of lambs. I should like to tell them of the usefulness of the simple device of light covers. Covers for older sheep have already proved most valuable in work on the chemistry of yolk by my colleague, Mr. W. G. Sutton. The

covers provided for my lambs protect the tips of the long fibres, which otherwise have largely become broken at the age of four or five months. For the classification of fibre types, it is necessary that the tips should remain intact. The covers also retain the loose birthcoat kemp. The kemps so far mainly studied are coarsely medullated fibres that complete their growth in a few weeks and are soon shed. The coarser of these can be recognised at birth as destined to fall out, but fibres having the structural features of the finer kemps may persist, being thinner and less medullated below the point at which a shed fibre completes its growth. The most satisfactory way to ascertain which fibres are shed is to hold them in the fleece by a cover. By sampling at suitable times, it is then possible to compare the numbers and types of shed kemp with the numbers and types of fibres which there is reason to regard as succeeding them in the same follicles.

The material that has been used is a brown proofed duck. Sometimes a complete band of about eight inches has been fastened round the middle region of the sheep; sometimes only the upper half has been covered, the band being held in position by elastic bands under the belly. In many cases this small cover has been protected by a larger one like a horse cover. The lambs were first covered when about two months old, adjustments having been made as required. Up to the present time, three months after covering, the tips have been sufficiently preserved. There is evidence that an extremely tight cover interferes with normal growth, but otherwise growth appears to be unaffected by covering. In work on shorter kemps that have completed their growth at birth, it will be necessary to put covers on at birth.

The study now in progress of the fibre types of the New Zealand Romney sheep and their development has reference especially, from the economic point of view, to the occurrence of medulla. From the practical point of view, kemps are not the most important medullated fibres in this breed, but they are the first to begin to grow, and an understanding of their place in the fleece is fundamental.

The work of Mr. J. A. Fraser Roberts on kemp in the Welsh Mountain breed has been very much in mind in this investigation. He has found that lambs with the same amount of birthcoat kemp may later have very different quantities of kemp. The problem thus raised is also encountered in the New Zealand Romney. I was much impressed by the statement, made in conversation several years ago, by Prof. J. E. Duerden, that associated with birth there is a check upon the growth of a lamb's coat. He was referring then to the form of his 'sickle-fibres', with a medullated sickle-shaped apical end, followed by a finger region, and he has suggested in a recent letter that the sub-apical thinning found in the majority of the bigger birthcoat kemps in the New Zealand Romney may be 'birth-thinning', as he calls it. This conception has come to be the guiding idea in the work now in hand. In the light of this 'birth check', the structural differences displayed by the array of fibre types, that begin their growth at different times, fall simply into line. Certain marked differences between individual animals in the array of fibre types are to be explained by differences in the intensity of the check at a series of corresponding stages of development. Differences in the time of onset and/or in the maximum intensity of the birth check are affording a satisfying explanation of differences in the relative numbers of certain fibres, especially sickle-fibres, that are shed or continue growing. I believe that an intense check causes fibres to persist that would be shed if the check were less severe. In the search for the significance of various other features in the development of the coat, the principle of the birth check promises to be illuminating. The birth check may well prove of interest, as an inhibiting effect, from the point of view of the physiology of heredity, but the need for an understanding of the respective parts played by genetic and non-genetic factors will at once be apparent.

A preliminary description of the fibre types of the New Zealand Romney hogget and their development appeared in the *Wool Record* of Sept. 4, 1930. I am enjoying the benefit of discussions through the mail with the biologists that have been mentioned. With the limitations inherent in work upon large, slow-breeding animals, it would be especially helpful to be in communication with any workers interested in related problems in other parts of the world. It is clear that there are radical differences, apart from fibre diameter, between the South African Merino and the New Zealand Romney in the structure and development of the fibre types. This fact is far from astonishing, but as the principle discovered by Prof. Duerden in the Merino is proving so helpful in work on the coarser woolled breed, the importance of comparative studies is emphasised.

F. W. DRY.

Massey Agricultural College,
Palmerston North,
New Zealand, Jan. 24.

Virulency of *Tilletia caries* on Wheat Varieties.

IN a letter in NATURE of Feb. 16, 1929, vol. 123, p. 243, I stated that certain wheat varieties thought to be resistant to bunt were susceptible when they were contaminated with the bunt spores that had been produced on those varieties. It was inferred that, in the same way that the plant breeder could select a unit from a population of a variety for resistance to a certain pathogen, so the mycologist might select a pathogen from an analogous population to which the given host was susceptible.

In the course of the past seven years, I have found no wheat variety that is consistently immune or very markedly resistant to this disease. In the majority of the varieties studied, it was sufficient to contaminate them with their own bunt; they were then susceptible: if not, they were found to be susceptible to bunt spores from other varieties—this bunt originating, so far as is known, from one source, namely, bunt that had been obtained on Little Joss wheat in 1923. For example, Hussar wheat contaminated with Little Joss spores in the season 1927–28 produced only 0·3 per cent of bunted ears, but in the succeeding season these spores were used to contaminate this same variety, and the estimated bunt percentage was then 49. It is suggested here that when traces of bunt are observed on a so-called resistant variety, this fact should not be ignored, as it has been in the past. It is thought this trace of bunt is a significant indication that a particular physiological form in the population of the parasite has found the given host susceptible. Perpetuation of that form on the particular variety may show it to be markedly susceptible.

That physiological forms of this parasite exist is shown by the following example: Martin wheat appears to be resistant in England to bunt produced on Little Joss wheat, since, during the past six years, bunted ears were observed twice only; the percentages 0·5 and 0·6 were recorded on those occasions. When, however, a sample of this wheat from the Cambridge plots was grown in Denmark and contaminated with indigenous bunt spores from a local

Danish variety, it produced 27 per cent of bunt. Martin wheat, when contaminated with bunt spores from White Odessa grown on the University Farm, Cambridge, produced 54 per cent of bunted ears, and this White Odessa bunt had grown previously on Little Joss wheat, and the spores originated, so far as is known, from the original inoculum obtained from Little Joss wheat in 1923. It is clear, therefore, that physiological forms exist; indeed, that this pathogen is analogous to the host which it parasitises, in that it is a population from which units may be obtained.

It may well be, however, that there were present naturally, on the original seeds of these varieties that were sown in 1923, a few bunt spores other than those with which I contaminated them artificially—physiological forms which would flourish in one environment and not in another.

Futhermore, in their study of *T. caries* many workers have undertaken very comprehensive experiments in order to determine the relative susceptibilities of wheat varieties to this parasite. So much so that collections of bunt—"botanical specimens of no commercial value"—have been forwarded from country to country that their virulent nature may be determined. I suggest that this is an excellent method for the commercial propagation and perpetuation of this disease—but one scarcely to be recommended in the best interests of agriculture. Although no varieties are universally immune, it may well be that certain varieties are moderately resistant to certain physiological forms in certain localities, and it is with these that the plant breeder and the practical farmer are concerned. It will not aid the cause of either to risk introducing foreign physiological forms.

It may seem that these two opinions are contradictory: for in one it is stated that no resistant varieties have been encountered; whereas, on the other hand, the opinion is expressed that it is most unwise to permit the introduction of physiological forms from one country to another, since it is to the detriment of both farmer and plant breeder. In certain environments, however, it may be possible to breed varieties resistant to indigenous physiological forms of this disease which would be susceptible to forms introduced from other countries.

W. A. R. DILLON WESTON.

Dominion Rust Research Laboratory,
Winnipeg, Man., Feb. 10.

Plant Distribution.

IN the course of work on the geography of the Angiosperms, I have been impressed by the absence of any satisfactory theoretical explanation of the more general features in the distribution of these plants. It will, I think, be agreed that the present distribution of the Angiosperms has been brought about by the intermingling, at different times and in different degrees, of a number of floras which have developed at different times and in different parts of the world. This being so, any general theoretical explanation must provide not only a means of actual plant-movement, and a motive force for it, but also a directional control of movement and a discriminating or sifting factor.

The dissemination of dispersal units obviously furnishes the means of movement, and the contemporary topographical outline and relief is clearly potent in controlling its direction. As to the motive force, it is generally believed to-day that plant migration has been and is caused by change in external conditions and particularly by climatic change. That is to say, change in external conditions is considered to make dispersal effective in bringing about changes in species position. There is little doubt that this belief is correct, but it cannot be looked upon as an explanation of the facts of plant geography unless there is added to it some explanation as to how external change can react so as to entail species movement.

It is one of the most obvious facts of plant distribution that a species can develop and maintain itself satisfactorily only within certain definite climatic and edaphic conditions; that it has, indeed, a 'range of tolerance' to external conditions. In view of this, it is possible to put forward the theory that 'range of tolerance' to external conditions—or, more shortly, 'tolerance'—is a specific character, subject to variation and change in the same ways and by the same means as morphological characters.

If this theory is accepted, then external change, which is itself a movement of conditions, must result in species movement, because dispersal, which is *potentially* in all directions, will be *effective* only in those directions which will maintain the spatial correlation between the species and the conditions within its range of tolerance. By the same theory, the necessary sifting effect among species will follow from the differential effect of one and the same external change upon species having different tolerances.

This theory of tolerance is set out and discussed at length in a forthcoming paper.

R. D'O. GOOD.

Department of Botany,
University College,
Hull, Feb. 19.

Sir Isaac Newton and the Greek Philosophers.

A FEW years ago I suspected that justice was not given to the brilliant astronomical discoveries of the ancient Greeks, and this led me to copy, to collect, and to classify several thousands of their passages relating to the structure and polity of the universe. A sound independent basis was thus established for checking the originality of the reformers of astronomy since the sixteenth century, and for rendering "unto Cæsar the things which are Cæsar's", in a very important period of the history of science.

The book of Copernicus, who had closely studied the philosophers of antiquity in their own language, broke down badly under the crucial and unanswerable test of comparison; and his heliocentric system is known to have been adopted from the Greeks without a single word of acknowledgment.

In the work of the great Kepler, I came across several theories that had already been propounded by the ancients; but that founder of modern astronomy was just and generous, and ever eager to applaud the discoveries of his predecessors, so far as he could be acquainted with their writings.

The treatment of the philosophers of antiquity by Newton is comparable with that of Kepler, and he did not hesitate to attribute to the Pythagoreans and to Aristarchus the discovery of the true system of the world. It is a well-known fact that, in the first century of our era, Plutarch conceived universal attraction, asserting, moreover, that gravity, counterbalanced by centrifugal force, prevents the moon from falling on the earth, like a stone in a sling. As Newton does not mention the philosopher of Chæronea, he evidently never saw the passages in which these ideas had been expressed. He did not understand the Greek language; and, like all great creators in science, he read little. Were he to have been acquainted with the scientific works of Plutarch, he would never have failed to do him justice, as he had done, for example, to Kepler for his famous laws, or to Bouillaud for the law of inverse squares.

There can, therefore, be no doubt that Newton started his inquiry by reasoning quite independently and in almost the same manner as Plutarch. His splendid genius was fully equal to the task of discovering anew those eternal truths that had dawned in the mind of the Greek philosopher. But there is an enormous difference between the mere conception of a scientific truth and its demonstration; and it is precisely that wonderful power of demonstration, backed, as it was, by mathematical intuition of the highest order and by an unrivalled use of induction and deduction, that has placed Newton above the men of science of all time.

E. M. ANTONIADI.

Paris, Feb. 22.

After-glow and its Life in Discharge Tubes.

DURING investigations with electrical discharges through various types of tubes, I have observed some peculiarities of the after-glow which appear to be worth recording. It is well known that the intensity and duration of the after-glow depend on the material of which the tubes are made. It is also believed that the duration of the after-glow ranges from a few seconds to a few minutes.

While working with silica tubes filled with gases at rather low pressures, I discovered quite a strong after-glow which persisted for about three-quarters of an hour. An after-glow of such a long duration appears to be very interesting, and this fact may throw some light on the proper understanding of the mechanism of the after-glow phenomenon. The tubes were excited by a small induction coil giving 400 volts for its output, and the discharge was passed for two minutes. During this time the tube did not show any appreciable rise in temperature. This phenomenon can be repeatedly observed any number of times. The after-glow in silica tubes is given not only by nitrogen and metallic vapours, as is believed by some experimenters, but also it appears to be associated with almost all gases, as well as metallic vapours. The glow is greenish when the current is switched off; but it soon develops into a yellowish white cloud filling the whole of the discharge tube, the density of illumination in the capillary portion being distinctly much higher than in the remaining portion of the tube.

The rate of decay of this glow is extremely slow, and its intensity appears to be largely controlled by the pressure of the gas—lower pressures, ranging between 0·01 mm. and 0·4 mm. of mercury, being very favourable to large intensity. The flash phenomenon recently recorded in NATURE (Nov. 8, p. 725) by Braddick is also seen in the after-glows of silica tubes; but instead of there being only a few flashes before the disappearance of the glow, as observed by Braddick, the glow in the present case shows the flickering of light for quite a long time, giving an appearance something like the scintillations observed in a spinthariscope.

Details of the above observations will be published elsewhere.

D. B. DEODHAR.

Physics Department,
University of Lucknow,
Feb. 5.

Colours of Inorganic Salts.

IN continuation of the letter published in NATURE, vol. 125, p. 163, Feb. 1, 1930, we wish to report that absorption spectra of vapours of chromic chloride and ferrous chloride were taken at temperatures of 1000° C. to 1400° C. in the vacuum furnace in order to test the theory postulated in the above communication. These substances were chosen because, according to information available in standard chemical literature, they do not dissociate within the temperature range mentioned and still yield sufficient vapour for absorption work.

It was found that chromic chloride yields a number of absorption bands at λ4100 A. and ferrous chloride at λ4350 A. These bands we ascribe to Cr^{+++} and Fe^{++}, and they are due to magnetic transitions in the d^3 and d^6 shells of these elements. In addition, we obtain continuous absorption, beginning from λ3000 A. and extending to the limit of our apparatus, namely, to λ2200 A. We ascribe this continuous absorption to the Cl^- ion.

This later conclusion is sharply at variance with the interpretation put by Franck and his students on the absorption spectra of vapours of saturated chlorides of monovalent elements like sodium and potassium, etc. They observed that with these vapours absorption begins near λ2900 A., and interpreted this as indicating the photo-dissociation of sodium chloride into neutral Na and neutral Cl, that is, $h\nu_a$ equals heat of dissociation of NaCl molecule, which was obtained from consideration of a Born cycle, ν_a being the frequency at which absorption begins. But vapours of almost all chlorides show absorption near λ3000 A. (it is not possible to locate this point with any degree of precision within 200 A. units), including the vapours of magnesium, aluminium, and silicon chlorides, which show no banded absorption, and by chromic chloride vapour and ferrous chloride vapour, which show band absorption. In these cases, the energy relations (correlation between $h\nu_a$ and heat of dissociation) as obtained from consideration of a Born cycle fail entirely. We are therefore led to the conclusion that the continuous absorption is due to the vibration of the electron in the Cl^- ion, but whether it leads to dissociation of a kind postulated by Franck cannot yet be answered definitely.

M. N. SAHA.
S. C. DEB.

Department of Physics,
University of Allahabad,
Feb. 12.

Transplantation of Portuguese Oysters into South African Waters.

IT is now well known that the accidental loss of a cargo of Portuguese oysters (*O. angulata*) in the Bay of Arcachon in 1866 resulted in this oyster establishing itself in the locality in a new environment. Arcachon now produces hundreds of millions of *O. angulata* annually. The possibility of successful transplantation of this species is therefore proved. If an accidental transplantation can be successful, it would appear that deliberate transplantation may be equally successful, provided a careful selection of the ground be made.

During a recent review of the distribution of oysters,[1] it was noted that oyster production on the South African coast appears to be infinitesimal in comparison with the apparent potentialities. The hydrographical conditions of the south-east coast of Natal would seem to be eminently suitable for the spawning and growth of the Portuguese oyster, a form which is absent from this region. It is suggested, therefore, that an experiment in the transplantation of this species might be as beneficial to South Africa as an unpremeditated one has been to France. *O. angulata* occurs on the north-west coast of Africa and possibly more southerly; its absence from South Africa may be due to the set of the relatively cold Benguela or Antarctic current on the south-westerly shores.[2] The Portuguese oyster

requires relatively warm conditions (68° F. or more) for spawning and good growth ; thus it is not unlikely that the general conditions intervening between the north-west and the south of Africa have acted as a natural barrier to the spread of this species of oyster in a southerly direction.

It is not improbable, therefore, that the artificial transplantation of the Portuguese oyster into South African waters might add a valuable economic product to that region.

Whether private individuals would undertake an experimental venture of this kind is somewhat doubtful, and the Union Government would probably have to finance the experiment, at least in its early stages, if after due consideration the undertaking were considered economically promising. It is possible that transplantation might be successful, but the experiment an economic failure, unless the economic factors are carefully borne in mind. J. H. ORTON.

The University, Liverpool.

[1] NATURE, **123**, p. 451, Mar. 23, 1929.
[2] J. M. Marchand, Report No. 7, Fish. and Mar. Biol. Survey, Union of South Africa, June 1929.

Deep Focus Earthquakes.

IN a report, issued by the Air Ministry and included in NATURE of Feb. 28 (p. 320), of an earthquake which was registered at Kew Observatory on Feb. 20, it was stated that the shock originated from a focus about 250 miles below the normal depth. It may be of interest to explain how it was possible to obtain this information from the records of a single station.

The first indication of deep focus was obtained from the comparatively feeble development of the surface waves. H. Jeffreys and others have pointed out that on theoretical grounds the amplitudes of surface waves should fall off very rapidly with increasing focal depth. For normal earthquakes the ratio of the maximum amplitude (as it appears on a Galitzin seismogram) of the surface waves to the amplitudes of the preliminary impulses is about 10 or 20. For the disturbance in question, the ratio is only about unity. It is difficult to recognise any well-defined maxima on the records.

The second indication is based on the results of an investigation which I have just completed and of which a detailed account will be published shortly. This research has shown that for earthquakes of deep origin, additional phases may be produced by reflection at points near the epicentre. To distinguish these waves from the ordinary reflected waves, *PP*, *SS*, etc., I have called them *pP*, *sP*, *sS*, etc. The times of transit have been calculated for various depths of focus. Some of these supplementary phases were recognised on the Kew records of the shock on Feb. 20 and confirmed the belief that the focus was abnormally deep. The estimate of the depth was obtained from the time intervals, which are as follows (*P* was recorded at 5 h. 44 m. 22 s. G.M.T.) :

	Observed. M.	S.	Calculated. M.	S.
pP - *P*	1	19	1	24
sP - *P*	2	2	2	4
S - *P*	9	19	9	20
sP - *P*	11	47	11	48

The calculated times are those corresponding to an epicentral distance of 77·5° (5370 miles) and a depth of focus of 0·06 of the earth's radius (that is, 250 miles), greater than normal.

F. J. SCRASE.

Kew Observatory,
Richmond, Surrey,
Mar. 2.

The Audibility and Lowermost Altitude of the Aurora Polaris.

FROM his very interesting account of the various observations on the aurora borealis, Prof. S. Chapman[1] concludes that doubt still exists regarding the audibility and low altitude of some auroræ.

On Aug. 10, 1928, I was at Fort Smith on Slave River in the Canadian north-west (lat. 60° N.), and witnessed a remarkable auroral display in the evening, about 11 P.M. In my notes at the time, it was likened to waving curtains illuminated by a slowly moving searchlight. The day had been uncomfortably warm and the aurora was a surprise, as I had always connected it with low temperatures. It was also quite different from the auroræ I had seen in Nova Scotia many years before.

In the constantly changing tints of this aurora, green and, to a less extent, yellow were the most conspicuous colours. Time after time these coloured streamers moved slowly across the sky, frequently almost horizontally, each one gradually slackening speed until it came to rest, and its movement was clearly accompanied by a low hissing or swishing sound like that of gas escaping from a tap under pressure. The sound, too, gradually died down with slackening speed of the streamer. Several of us watched this display for more than an hour. We were on the deck of a small steamer at the riverside, from which the bank sloped steeply upwards for some hundreds of feet. This afforded some basis for estimating the height of the aurora, and it seems certain that it could not have been greater than a fraction of a mile. The fact that there was no perceptible lag between sight and sound, shows that the distance could not have been great.

Finally, this aurora was in striking contrast with others which I had witnessed as a youth in Nova Scotia in winter. These 'northern lights', as I remember them, consisted mainly at least of white light, and were often like the streamers from searchlights projecting upwards into the sky. They were sometimes accompanied by low crackling sounds, and gave the impression of being far away to the northward. Thus it appears clear that there are two quite distinct types of aurora. R. RUGGLES GATES.

King's College, London,
Mar. 9.

[1] NATURE, Mar. 7, 1931, p. 341.

Faraday Relics.

THE Institution of Electrical Engineers and the Royal Institution are combining to commemorate, in September next, the centenary of Faraday's discovery of electromagnetic induction, and in connexion with the celebrations an exhibition is being arranged at the Albert Hall.

The Royal Institution is contributing to this exhibition Faraday's original apparatus and illustrations of his experiments. In addition, it is hoped to arrange at the Royal Institution itself a smaller exhibition of relics of a more personal character.

The Managers of the Royal Institution would be glad to hear of personal relics, apparatus, and manuscripts of Faraday ; and those who possess any such objects and are willing to lend them for exhibition are asked to communicate with the General Secretary, Royal Institution, 21 Albemarle Street, W.1.

W. H. BRAGG
(Director).

The Royal Institution,
21 Albemarle Street, London, W.1,
Mar. 18.

Oceanographical Expedition of the *Dana*, 1928–1930.*

By Prof. Johannes Schmidt, Ph.D., D.Sc.,
Carlsberg Laboratory, Copenhagen, Leader of the Expedition.

The Distribution of *Nessorhamphus*, a New Genus of Oceanic Eels.

As a biological example I may refer here to a new genus of pelagic eel which I am describing elsewhere under the name of *Nessorhamphus*.[1] It is readily distinguished from other eels by the spatulate snout—so that seen from above it reminds one somewhat of the elongated beak of a duck—and the hind margin of the caudal fin, which is not rounded (Fig. 4).

For several years I have known *Nessorhamphus* from the Sargasso Sea of the North Atlantic, our collections containing all stages from the egg and tiny larva up to adult specimens. The larvæ are specially numerous; they occur in thousands and are thus well suited to the determination of the distribution, especially the breeding areas.

During the *Dana's* voyage round the world we discovered that *Nessorhamphus* also occurs in the other oceans, in the Pacific as well as in the Indian Ocean, and the details of its distribution seem to me of so much interest that I propose to discuss them briefly here, even though the collections are not yet fully worked out. In the western part of the Indian Ocean, around Madagascar, we found both larvæ and adolescent specimens of *Nessorhamphus*. Closer examination showed that they stood so near *N. ingolfianus* of the Sargasso Sea that they must be referred to this species; at the most, it can only be a matter of subspecific difference. Comparison of the following averages of several important numerical characters in 200 larvæ from the North Atlantic and 70 from the Madagascar region proves this:

Nessorhamphus ingolfianus.	Total No. of Myomeres.	Preanal No. of Myomeres.	Postanal No. of Myomeres.	Large Blood-vessel on Myomere. No.
North Atlantic .	154·05	120·28	33·79	75·3
Indian Ocean around Madagascar . .	153·91	120·69	33·06	75·6

On the other hand, to the west of Sumatra, in the neighbourhood of the equator, the *Dana* obtained two adolescent specimens (in addition to larvæ) of a *Nessorhamphus* which was seen at the first glance to be different from *N. ingolfianus*, and which I am introducing into ichthyological literature here under the name of *Nessorhamphus Danæ*, nov. sp.

* Continued from p. 446.

The most obvious character is a deep black, well-marked streak extending along the middle line ventrally from the head to somewhat past the anus (Fig. 4, *B*); this streak is wanting in *N. ingolfianus*.

N. Danæ also differs in other characters; thus, the snout is relatively shorter and the distance between front of dorsal fin and the vent relatively longer. The numerical characters also show differences. The number of vertebræ in one of the specimens from Sumatra was found to be 137 (corresponding to 138 myomeres in the larval stage), whereas in 100 larvæ from a station in the Sargasso Sea the myomere numbers varied from 150 to 159, and in 65 specimens from the Madagascar region from 149 to 158.

In the Indian Ocean we found *Nessorhamphus Danæ* not only west of Sumatra but also on both sides of the equator farther west, in the waters between the Maldives and Seychelles; and in specimens from the equatorial parts of the Indian Ocean the number of myomeres varied between 135 and 145, thus showing a range of variation similar to that of *Nessorhamphus ingolfianus* in the Sargasso Sea and round Madagascar.

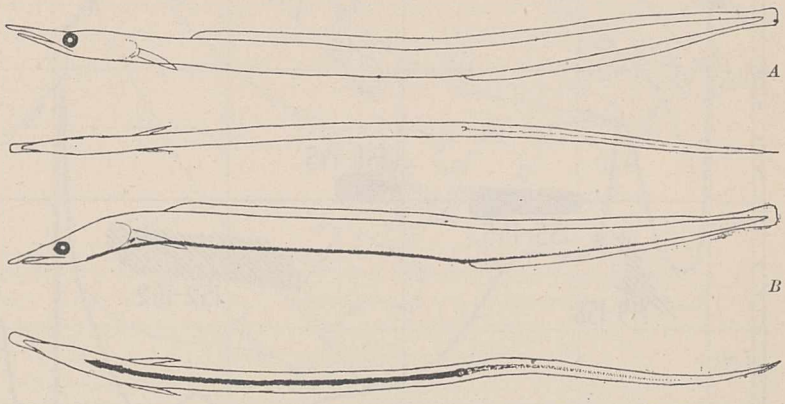

Fig. 4.—*Nessorhamphus ingolfianus*, Johs. Schmidt (*A*), and *Nessorhamphus Danæ*, Johs. Schmidt (*B*), side and ventral views. (*A*) specimen 128 mm. in length, from the Sargasso Sea; (*B*) specimen 102 mm. in length, from the Indian Ocean west of Sumatra. Drawings by Dr. Å. V. Tåning.

In the Pacific we found *Nessorhamphus Danæ* in the equatorial belt north of New Guinea and Celebes, etc., the number of myomeres varying here between 136 and 145.† *Nessorhamphus* also proved to occur in the south Pacific along the whole stretch from the Marquesas to New Caledonia and the north-western part of the Tasman Sea, but this was not *N. Danæ*. It was a form which approaches *N. ingolfianus*, both in its high number of vertebræ and the absence of the ventral streak which characterises *N. Danæ*.‡

Turning now to the third ocean, the Atlantic, no specimens of *Nessorhamphus* were found by

† For twenty-seven specimens the averages corresponding to those given in the previous table were 140·37—112·19—28·19—72·04.

‡ The number of myomeres varied in six specimens from 152 to 162, but in such a small number of specimens this is such a wide range that possibly a mixture of two forms is present.

the *Dana* in the southern portion, from the Cape towards Ascension; but in the neighbourhood of the Line, on both sides of this, a few larval specimens were found which proved to belong to *Nessorhamphus Danæ*, with the number of myomeres varying from 135 to 145.

The distribution of the genus *Nessorhamphus* is summarised in the accompanying chart, Fig. 5. This is based on the occurrence of larvæ and thus represents the breeding regions. As in all eel fishes, these are restricted to the warmer parts of the oceans. For the rest, the most characteristic features of the distribution may be summed up as follows:

1. Both main species, *Nessorhamphus Danæ* and *N. ingolfianus* (each including subspecies or races) occur and spawn in all three oceans.

2. In each of the oceans the two species are distributed in the same manner, with regard to latitude, as in the other two oceans. Thus, *Nessorhamphus Danæ* occurs in a belt about the equator, whereas *N. ingolfianus* is found about the transitional circles, both on the northern and southern hemispheres. We may call this type of distribution the latitudinal.

This is the actual distribution of the genus *Nessorhamphus* so far as the *Dana's* investigations go. Large regions of the oceans, however, in the North Pacific and South Atlantic for example, must be investigated before the picture is complete. It would not be remarkable if it proved that the transitional region of the North Pacific contained a fish belonging to the form-series of *N. ingolfianus*, or at any rate to a related species, for the hydrographical conditions there, at least in the western part, greatly resemble those of the Sargasso Sea. One must similarly take into account the South Atlantic in the neighbourhood of the transitional circle, especially its western part, where the hydrographical conditions also recall to some extent those of the Sargasso Sea. I have not much doubt that *N. ingolfianus* extends from Madagascar across towards Australia, and that *N. Danæ* occurs from New Guinea far to the east in the equatorial belt.

From our investigations of the home fishes we know what great importance the hydrography, and especially the temperature, has in the distribution of the different species, more especially at spawning time. In 1909 I illustrated this in the case of the North Atlantic species of Gadoids, and demonstrated that it is the varying temperature requirements in the different species during the spawning period, when the species are specially sensitive, which determines the situation of the spawning

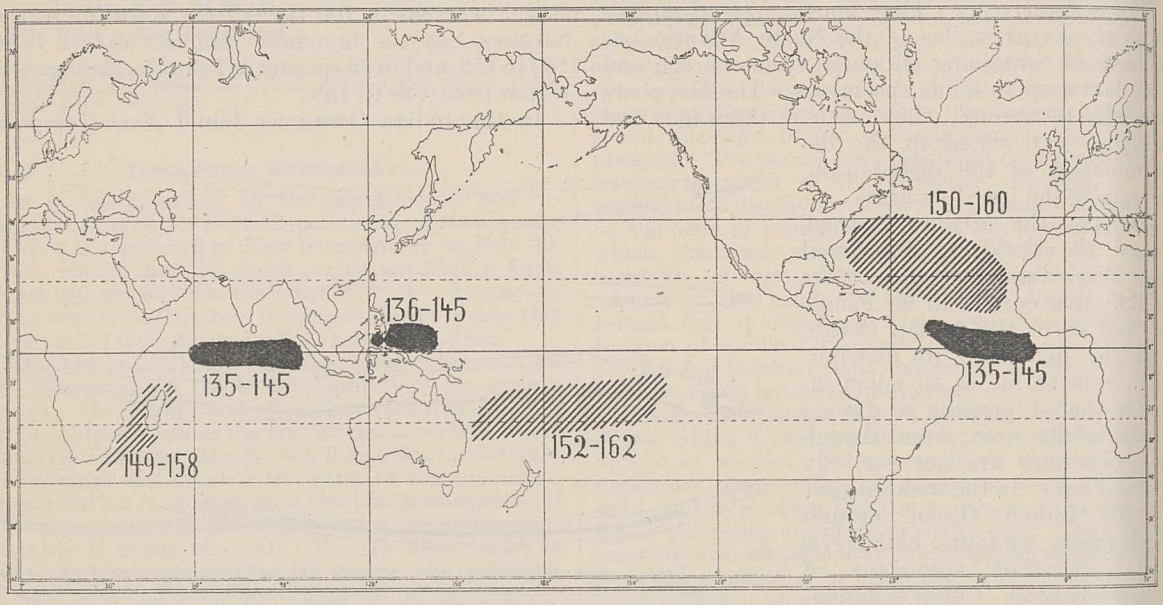

FIG. 5.—Distribution of the larvæ of *Nessorhamphus ingolfianus*, Johs. Schmidt, shaded, and of *Nessorhamphus Danæ*, Johs. Schmidt, black (each including subspecies or races). The figures denote number of myomeres.

grounds and thus right away the distribution of the different species.[2] Also, there can be no doubt that in the case of the oceanic fishes it is also the hydrography—making allowances for the historic factors—which determines the breeding areas of the species and thus in the first case their distribution.

Now, large and characteristic differences actually occur between the equatorial zones and the zones about the transitional circles in hydrographical characters, both in the upper and intermediate water layers, where the propagation and larval development of *Nessorhamphus* take place. This applies to the temperature, salinity, oxygen contents, etc., and it cannot be doubted that such differences, in conjunction with specific demands on the environmental conditions, determine the spawning regions and distribution of the two *Nessorhamphus* species.

The further examination of the *Dana* material will presumably bring to light types of distribution other than the latitudinal, as in *Nessorhamphus*; but this will undoubtedly be found again in many other cases, possibly with even greater clearness in other cosmopolitan genera of oceanic fishes,

especially in those which contain several main species, and, in contrast to the eel fishes, are not restricted to the warm zones but also occur and spawn in regions of lower temperatures.

The above information regarding *Nessorhamphus* may be taken as a first example of what may be reached from two months' work, dealing with the *Dana* material from the point of view outlined in the beginning—that is, by using biometric methods and including the large larval material. Without the latter, from the study alone of the quite few adult specimens available, we should not have understood in the least the peculiar features of the distribution of the genus. Even if a great deal is still wanting, it is certainly not a common thing in natural history, along with the description of a new genus, to be able to give so much regarding the distribution of its species.

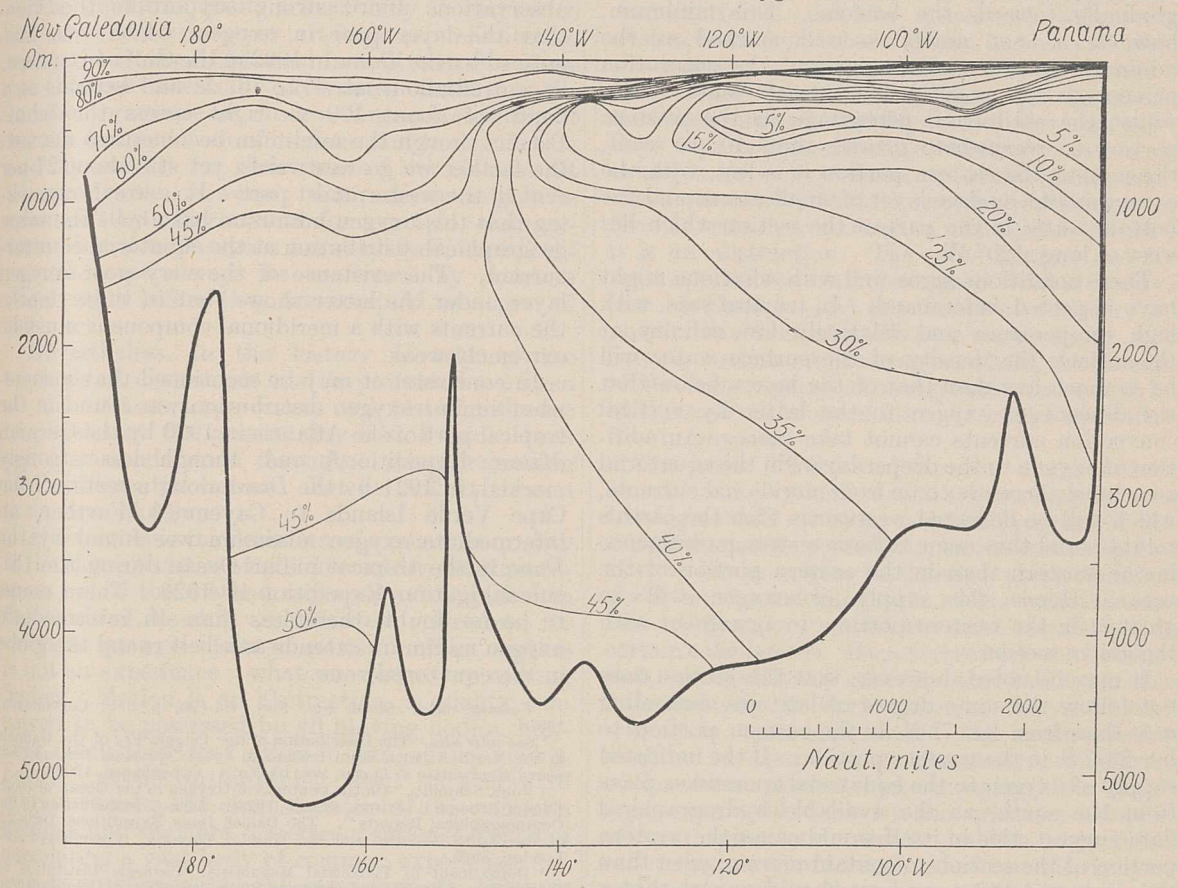

FIG. 6.—Section of the ocean from Panama to New Caledonia, showing distribution of oxygen.

OXYGEN IN THE TROPICAL PACIFIC.

By HELGE THOMSEN, Hydrographer of the Expedition.

On the 1921–22 expedition with the Royal Danish Research Ship *Dana* the remarkable fact was discovered, at several stations in and close to the Gulf of Panama, that the sea water contained practically no oxygen at a depth of *c.* 400 m., but at that time there was no opportunity of following up the horizontal distribution of this phenomenon.[3] As the projected course of the *Dana* in its world cruise in September 1928 lay across the Pacific from Panama to New Caledonia, one of the principal hydrographical aims of the expedition, as planned by its leader, was the investigation of the minimum distribution of oxygen towards the west.

The result of these investigations, which were undertaken in the months of September, October, and November 1928, is displayed in Fig. 6, which shows the oxygen distribution in a section from Panama to the south point of New Caledonia, the position being given on the route-chart, Fig. 2. The figures on the curves denote the percentage of oxygen observed, compared with the quantity of oxygen which would be found in the water if it were saturated with oxygen. The smallest quantity was found in the Gulf of Panama at a depth of 400 m. and amounted to 0·03 c.c. of oxygen per litre of sea water, corresponding to 0·5 per cent saturation. This minimum extends westwards from the Gulf of Panama, always with nucleus about 400-500 m., but with steadily rising amount of oxygen. As far as long. 125° W. the minimum value still remains less than 10 per cent, and up to *c.* long. 140° W. less than 20 per cent; but about long. 148° W., that is, near Tahiti, the minimum ceases to be apparent in the saturation percentage.

Consideration of the section shows, further, that

it may be divided naturally into two portions with the boundary about Tahiti. In the eastern portion the amount of oxygen diminishes very rapidly with the depth down to the minimum at 400-500 m., thereafter increasing again towards the bottom, where increasingly higher values are obtained the farther one goes westwards.

On the other hand, in the western portion of the section we find a slower decrease in the amount of oxygen with the depth, until a minimum is reached at *c.* 2000-2500 m., after which it again increases gradually towards the bottom. This minimum, however, is not nearly so well marked as the minimum in the eastern portion, the saturation percentage not going below 40 per cent. Thus, whilst the saturation percentage in the western portion is everywhere greater than 40 per cent, throughout the eastern portion it is less, with the exception of a surface layer of small extent and the bottom water in the part of the section which lies west of long. 120° W.

These conditions agree well with what one might have expected beforehand. In tropical seas, with high temperature and relatively low salinity at the surface, the density of the surface water will be so much less than that of the layers below that the descent of oxygen to the latter by vertical convection currents cannot take place. An addition of oxygen to the deeper layers in the equatorial zone must therefore come from meridional currents, which will be deflected westwards with the earth's rotation and thus come to have a stronger influence in the western than in the eastern portion of the ocean. Hence the supply of oxygen will be greatest in the western portion, in agreement with the above section.

It may be noted, however, that this section does not follow the same degree of latitude, extending as it does from lat. 7° N. in the eastern portion to lat. 23½° S. in the western portion. If the indicated supply of oxygen to the equatorial zone takes place from the south, as the available hydrographical data suggest, this in itself would cause the western portion of the section to contain more oxygen than the eastern portion, and we should expect that a section due west from the Gulf of Panama would contain less oxygen than the foregoing. Other observations indicate that this view is very probable. For example, the American Carnegie Expedition, working in these waters a year after the *Dana*, found an oxygen minimum of 0·5 to 1 per cent in depths between 100 m. and 400 m. at *c.* lat. 12° N. and long. 137° W.[4] This minimum is of the same dimension as that found by the *Dana* expedition at Panama and considerably less than the minimum measured by the *Dana* on the same degree of longitude but some twenty degrees more to the south.

In July 1929, when the *Dana* expedition was working in the waters north of New Guinea, an oxygen minimum of 27·3 per cent was found in 400 m. at lat. 3° 40′ N. and long. 137° 40′ E. These observations afford strong support to the view that the layer poor in oxygen, which was first noticed by the *Dana* in 1922 in the Gulf of Panama, is centred about lat. 5° to 10° N. and extends at a depth of about 400 m. right across the whole Pacific, though the minimum becomes less marked the farther we go westwards, yet still about 27 per cent in the westernmost part. It is worth remarking that this oxygen minimum has about the same geographical distribution as the equatorial countercurrent. The existence of the very poor oxygen layer under the latter shows that in these depths the currents with a meridional component must be extremely weak.

In conclusion it may be mentioned that a somewhat similar oxygen distribution was found in the tropical part of the Atlantic in 1926 by the German *Meteor* Expedition,[5] and, though less strongly marked, in 1921 by the *Dana* along a section from Cape Verde Islands to Cayenne.[6] Further, an intermediate oxygen minimum was found by the *Dana* in the tropical Indian Ocean during the Circumnavigation Expedition in 1929. There seems to be no doubt, therefore, than an intermediate oxygen minimum extends as a belt round the globe in the equatorial zone.

[1] *Vidensk. Med. Dansk Nat. For.*, vol. 90, p. 371; Copenhagen, 1931.

[2] See *inter alia* "The Distribution of the Pelagic Fry of the Gadoids in the North Atlantic from Iceland to Spain" (*Conseil International pour l'Exploration de la mer*, vol. 10, No. 4; Copenhagen, 1909).

[3] Johs. Schmidt, "On the Contents of Oxygen in the Ocean on both sides of Panama" (*Science*, June 5, 1925). *Idem*, "Introduction to the Oceanographical Reports". The Danish *Dana* Expeditions, 1920–22, in the North Atlantic and the Gulf of Panama. Copenhagen and London, 1929.

[4] Department of Terrestrial Magnetism. Carnegie Institution of Washington: *Reports and Communications to Section of Oceanography*. Washington D.C., June 30, 1930.

[5] H. Wattenberg, "Die Durchlüftung des Atlantischen Ozeans" (*Journal du Conseil International*, vol. 4, No. 1, Copenhagen, 1929).

[6] J. P. Jacobsen, "Contribution to the Hydrography of the North Atlantic". The Danish *Dana* Expeditions, 1920–22, in the North Atlantic and the Gulf of Panama. No. 3, Copenhagen and London, 1929. Johs. Schmidt, "Introduction to the Oceanographical Reports", *ibid.*, No. 1, Copenhagen and London, 1929.

The Nature and Scope of Physical Science.*

I.

By Prof. HERBERT DINGLE.

SCIENCE may be defined as the recording, augmentation, and rational correlation of those elements of our experience which are actually or potentially common to all normal people. The phrase cannot boast of elegance, but for clear thinking, rigidity and conciseness are the important considerations.

To prevent excessive misunderstanding, some explanations are necessary, which limits of space compress to the barest minimum. By 'experience' is meant everything of which we are conscious except rational conceptions. Experiences 'common to all normal people' may for practical purposes be thought of as observations made by means of the senses, but since what fits them for scientific discussion is not the way in which we get them

* Substance of a course of four lectures delivered at the Royal Institution on Jan. 22, 29, Feb. 5 and 12.

but the fact that they are universal, the more general description is preferable. By expressing the data of science as experiences and not as the external world giving rise to them, we evade the problem of the objectivity of that world; that is a problem for philosophy, not for science. Finally, the word 'potentially' is inserted in the definition merely to include observations which might be made but are not; it is not a loophole for the admission of hypothetical experiences which future developments of the human organism might make possible.

The definition limits science only in respect to its data and its purposes; it imposes no limitation on method. As a historical fact, of course, science has almost invariably restricted itself to the familiar processes of observation and experiment for the accumulation of its data, and to abstraction and hypothesis for their rational correlation. It is conceivable, however, that science might be advanced by other means, for example, clairvoyance; but if such means are employed, their indications must always be confirmed by common observation before they are accepted as a part of science.

Nevertheless, in the history of science, the methods of abstraction and hypothesis have been of the utmost importance, and the significance of physics at the present day has, I think, been widely misunderstood through a misapprehension of their essential nature. Let us look at them a little more closely.

Abstraction is the detection of a common quality in the characteristics of a number of diverse observations; it is the method supremely exemplified in the work of Newton and Einstein. Newton, for example, gave us 'laws of motion'. Now, motion is not an experience; what we observe are moving bodies. Motion is an abstraction, a quality conceived to be possessed by all moving bodies, however much they may differ in size, shape, colour, beauty, virtue, or anything else. The laws of motion express the characteristics of this common quality, and they are therefore a rational means of correlating a vast body of common experience.

A hypothesis serves the same purpose, but in a different way. It relates apparently diverse experiences, not by directly detecting a common quality in the experiences themselves, but by inventing a fictitious substance or process or idea, in terms of which the experiences can be expressed. A hypothesis, in brief, correlates observations by adding something to them, while abstraction achieves the same end by subtracting something. For example, to correlate the motion of Uranus with that of the other planets by abstraction in the year 1845 would have been a terrifying business. The simpler plan was adopted of supposing the existence of another planet which, with Uranus, obeyed the laws of motion abstracted from the behaviour of the more familiar planets, and the problem was solved.

A hypothesis of this kind can be "proved to be true". That is, of course, what occurred in the example just given, which led directly to the discovery of the planet Neptune. But there are other hypotheses which cannot be thus verified; for example, the supposed birth of the planets through the influence of a passing star. This is not the only, nor at the moment the most conspicuous, type of unverifiable hypothesis, but we shall return to this point later.

The mental processes involved in abstraction and the formulation of hypotheses can be traced back through the ages. At the beginning of modern physics, however, only the method of abstraction was employed. Newton was the sworn foe of hypotheses. The elements of his philosophy —mass, force, absolute space and time—were abstractions from observations, in terms of which the processes of the physical world were described. He always strenuously opposed the imputation that he employed hypotheses, and although nowadays it is commonly stated that gravitation, for example, is a hypothesis, it could be shown, if space permitted, that it expresses nothing more than is actually contained in observation; that is, it is an abstraction. The same method has now been applied to a more extensive field of observation by Einstein, and the theory of relativity is a pure abstraction after Newton's own heart. The equations of the electro-magnetic field, the principle of the conservation of energy, and the second law of thermodynamics are other examples of abstraction in physics.

The great influence of Newton dominated the activities of physicists and mathematicians during the eighteenth century, and the progress of that time is summed up partly in the successful application of his principles to detailed phenomena and partly in the reformulation of his essential ideas into alternative expressions more convenient for certain calculations. Hypotheses were at a discount. But, fortunately for science, other influences were independently at work which, so far as physical science is concerned, found the most effective medium of operation in chemistry. Chemistry, no less than physics, had throughout the Middle Ages been held back by the arbitrary adoption of 'principles' and 'occult qualities', but it had suffered no martyrdom such as had canonised physics and astronomy in the person of Galileo. It had therefore no need of a formal body of doctrine, and while it could profit by the purifying influence of the great physicists, it could also regard with tolerance what to them was heresy. Consequently we find chemistry freeing itself from superstition more gradually than physics, but at a smaller cost. Thus, while Newton was declaiming against hypotheses, Stahl was conjuring up the spirit of phlogiston which was to direct chemical progress for the next hundred years. This freedom of chemistry to be influenced, but not controlled, by the mathematical revolution is of the utmost importance, for by the gradual merging of the two sciences into one, physics has slowly become emancipated from the restrictions which Newton imposed, although whether she has done so without sacrificing the principles for the sake of which he imposed them is a matter of grave doubt.

I have neither space nor knowledge to trace in detail the introduction of hypotheses into physics.

To illustrate the process, however, here are three quotations from representative men of science, covering the period from Newton to the present time and separated by roughly equal intervals. The first is from Newton himself (1687): "I frame no hypotheses. For whatever is not deduc'd from the phænomena, is to be called an hypothesis; and hypotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy." The second is from Laplace (1796): "I will suggest an hypothesis which appears to me to result with a great degree of probability, from the preceding phenomena, which, however, I present with that diffidence, which ought always to attach to whatever is not the result of observation and computation". The third is from Eddington (1926): "Care is taken to provide 'macroscopic' equations for the human scale of appreciation of phenomena as well as 'microscopic' equations for the microbe. But there is a difference in the attitude of the physicist towards these results; for him the macroscopic equations—the large-scale results—are just useful tools for scientific and practical progress; the microscopic view contains the real truth as to what is actually occurring." The direction of development is obvious, and its validity is the most vital question, both for the philosophy of science and for the application of scientific ideas to other departments of thought, at the present time.

The introduction of the atomic hypothesis into physics raises the question of the significance to be ascribed to hypotheses which postulate entities (such as atoms and electrons) which are essentially unobservable. I think the conclusion is inescapable that such entities can be regarded only as concepts, possessing no properties and subject to no laws other than those which are necessary and sufficient to enable them to correlate observations. The question whether they are *real* or not is already answered in the designation of them, for we can scarcely regard anything as real, in the sense in which observed existences are real, which is essentially unobservable. If we adopt such hypotheses, therefore, we have perfect freedom to shape them as we please, provided they achieve the end for which they were created. We are not bound to give them the characteristics of phenomena. They are employed for rational correlation and are not admissible to experience; they must therefore have rational properties, but not necessarily sensible ones.

This, however, was overlooked by the physicists of the early twentieth century, who appeared to be faced by an irresolvable dilemma in the inability of the atom to emit radiation without self-destruction. The position was that either the solar system model of the atom, to which the development of the atomic hypothesis had apparently inevitably led, or the laws of electro-magnetism, abstracted from phenomena, had to be left out of consideration if the atomic hypothesis was to be extended to include the interaction of matter with radiation; and physicists in general were willing to abandon neither. Why was this?

It was simply that they did not realise the essential character of a hypothesis. The atoms, being hypothetical units, were in their hands to mould to the dictates of their imaginations, and they did not know their own freedom. They thought of atoms, not as hypotheses but as potential phenomena and therefore necessarily subject to the laws already established for phenomena by the method of abstraction. The process began when atoms were first introduced into physics. At that time they were supplied instinctively with mass and the other Newtonian abstracted qualities, and the implication that they were potential phenomena took such hold of succeeding physicists that by the twentieth century its arbitrariness needed a genius to perceive it. Fortunately the genius, in the person of Neils Bohr, was at hand. Bohr retained the solar system model of the atom, but absolved it from obedience to the laws of electromagnetism.

This step of Bohr's was the most significant in physical science since the introduction of the hypothesis of atoms. What virtually it did was to establish the fact that the hypothetical atoms were pure conceptions: that they belonged essentially to a different category from the facts of observation. They were creatures of the imagination, to be formed into the image of our fancies and restricted by whatever laws we cared to prescribe, provided only that when they behaved in accordance with those laws they should reproduce phenomena. They were removed from the realm of experience and deposited in that of reason.

Developments have succeeded one another with almost alarming rapidity, but from the fundamental point of view nothing new has happened. The solar system model has gone and a conception devoid of any pictorial aspect has taken its place, but that—if in so speaking we may disclaim any disrespect to the brilliant physicists who have organised the process—is but the ass's kick at the dead lion. Whatever formal doctrine physicists may profess, they exhibit in practice no more belief in the phenomenal reality of atoms than in the philosopher's stone.

News and Views.

THE Duddell Medal for 1930 of the Physical Society was presented to Sir Ambrose Fleming at the annual general meeting of the Society on Mar. 20. The medal is awarded not more frequently than once a year to persons who have contributed to the advancement of knowledge by the invention or design of scientific instruments or by the discovery of materials used in their construction. Sir Ambrose Fleming's connexion with the Physical Society dates back to its very beginning, for he read the first paper at the inaugural meeting of the Society in March 1874. In 1879, Sir Ambrose designed a special form of resistance balance for comparing standard coils, and a special form of standard coil capable of taking up

more quickly the temperature of the water in which it was placed than the form before in use. When practical incandescent electric lighting began, and quick and accurate workshop methods of electrical measurement became necessary, he made, in 1883, the first direct reading potentiometer set to read directly current and potential in amperes and volts by means of a standard Clark or Weston cell. Sir Ambrose also designed a form of wattmeter, with which he made extensive researches on alternating current transformer efficiencies, reported to the Institution of Electrical Engineers in 1892. In this paper he first suggested the use of the term 'power factor', which at once came into everyday use.

WHEN practical wireless telegraphy first began under Marconi in 1898, no appliances were obtainable for measuring wave-lengths and frequencies. In 1904, Sir Ambrose Fleming invented his cymometer, which provided a simple instrument for this purpose, capable also of measuring decrements and small capacities and inductances, and, in conjunction with Prof. Clinton, he also devised a rotating commutator for measuring the capacity of aerial waves and Leyden jars used in wireless. In 1904, he invented his now famous two-electrode thermionic valve, which prepared the way for the subsequent improvement of the three-electrode valve which is now the master weapon of the radio-engineer. Between 1892 and 1895 he carried out, in conjunction with the late Sir James Dewar, extensive researches on the electric and magnetic properties of matter at low temperatures, and devised for this purpose special forms of resistance coil, condenser, and bridge and potentiometer for the measurement of resistances, inductive capacities, and thermo-electromotive force. He was the first to establish a laboratory for high frequency and radio measurements, at University College, London, where he was professor of electrical engineering for forty-two years.

THE British Science Guild has submitted to the Royal Commission on the Civil Service a memorandum upon the structure and organisation of the Civil Service, dealing with what it describes as a "national imperfection". The Guild points out that in many present-day problems confronting Government Departments the technical and scientific aspects are of paramount importance, and it is therefore essential that an officer of the 'expert' class should be given the fullest opportunity of advancing his views and opinions, if necessary, in the presence of the ultimate authority, namely, the Minister. It accordingly advocates the development of the board system as it obtains in the larger and more progressive industrial undertakings. At the same time, the Guild states that it is necessary, in order to attract men of first-rate scientific and technical ability to the Civil Service, that "steps should be taken to remove the idea that the status of the officers performing scientific and technical duties in the Civil Service is inferior to that of the administrative and clerical groups".

THE heads of the larger and more important professional, scientific, and technical departments of the Civil Service should, the British Science Guild claims, be given the status accorded to the highest administrative officers. The Guild doubtless has in mind the fact that, whereas there are some thirty 'administrative' posts carrying a salary of £3000 per annum and a greater number with a salary of £2200, there are only some three or four posts on the professional or scientific side with a salary of as much as £2500, the remainder receiving in every case less than £2000. The Guild further maintains that the fact that an officer with administrative gifts happens to be a professional man should not in practice debar him from administrative preferment. Finally, it is urged that the time is ripe for a simplified structure for the technical services—using that term in the broadest sense—based on their essential underlying unity, namely, the discovery and application of scientific principles for the good of the community and the increased efficiency of the services administered by the State, and in this connexion, reference is made to the proposals for such a simplification which have been put forward by a Canadian Royal Commission for the assimilation to seven grades of an "unnecessarily cumbrous" structure of 203 separate professional, scientific, and technical grades.

THE Commission appointed by Congregation in March 1930, to advise the University of Oxford as to the best method of securing such library provision as shall be abreast of modern requirements, has issued its report. The report is marked "confidential"; but its principal contents are matters of common knowledge, and are now being freely discussed. The only portion of the report that directly affects the scientific interests of the University is that dealing with the present condition and future development of the Radcliffe Science Library, now housed within the precincts of the Museum. The building known as the Radcliffe Camera was the first home of the scientific and medical library provided and maintained under the bequest of Dr. John Radcliffe in the early days of the eighteenth century. In 1860, the scientific and medical books were removed, with the consent of the Radcliffe Trustees, to quarters in the recently established Museum in the Parks; here they remained until in 1901 the present building, the gift of the Drapers' Company, was completed and ready to receive them. Since 1927, the Science Library has become the property of the University; it is administered by the Bodleian Curators, the Radcliffe Trustees contributing £1500 a year towards its maintenance. The Commission reports that the present system is well adapted to the needs of workers in science, but it is considered that further accommodation for books and staff is essential. A prolongation towards Parks Road and northward along it is recommended, the extended building being roughly L-shaped.

THE British Arctic Air Route expedition in Greenland has sent a note, published in the *Times* of Mar. 18, on its plans for exploration during the coming summer. One of the aeroplanes is badly damaged and the other requires some repairs, but both will be available to relieve the party on the interior ice cap and to support

a party that is to explore the coast regions to the north of the base on Sermilik fjord. This party set out with dog teams on Mar. 14 to map the inland edge of the ice-free margin of the coast between Sermilik fjord and Kangerdlugsuak fjord. They are travelling on the edge of the ice cap and hope to explore a lofty mountainous area which the expedition sighted last year, at the head of the last-named fjord. This is approximately the region named Schweizer Land by Quervain in 1912. It contains at least one peak more than 11,000 ft. in height. The coast of this stretch of land was mapped in detail last summer. A second party is to move south from the base, mapping the coast, which is little known, for about a hundred and fifty miles. This party will travel relatively easily over the sea ice and obtain plenty of food from seals. Sermilik fjord is also to be re-surveyed. Thus the entire expedition will be in the field during the spring and summer months. Mr. H. G. Watkins, the leader, believes that if an air route over Greenland to Canada proves feasible, it will cross the east coast between Angmagssalik and Kangerdlugsuak fjord.

ON Mar. 18, the Symons Memorial Lecture was delivered before the Royal Meteorological Society by Comdr. E. C. Shankland, his subject being "Navigation from the Viking Period to the Present Day in relation to Science and Meteorology". Comdr. Shankland sketched the probable ideas which lay at the back of the Vikings' schemes for voyaging first westward, then south-westward, and finally making voyages of more than 2000 miles. The information of climatic conditions existing in the ninth century which we possess from reference to early literature provides an interesting possibility that there was an extremely dry period for several years. As without precipitation there can be no surface moisture and consequently ice, the presumption that many parts of north Europe, such as Greenland, now perennially ice-covered, were dry and open for exploration, may have induced the Vikings to venture afield to some remote places overseas. So much of the world's navigation history has been made and adventure commenced in the North Atlantic (either from the British Isles, Scandinavian, or Continental seaports), that the use of an elementary sextant to maintain the measurement of latitude by the polar star was, in Comdr. Shankland's opinion, used prior to the compass or lodestone in Europe. Cargoes carried by ships are the product of the land, and any port enjoying trading facilities and relations with the more habitable portions of the earth must be at an advantage if centrally situated. The want of local knowledge of the weather in the North Sea and Irish Sea was probably the greatest meteorological event in our history, as it contributed towards the loss of the Spanish Armada and so gave Britain the freedom of the seas. Among modern practices, the wind pressure on ships, and the utility of the barometer in gauging the lifting power of salvage pumps in salvage operations, were explained.

WITH the current issue for March, *Antiquity* enters upon the fifth year of its existence. Those who are responsible for its publication have earned congratulation and deserve every support. *Antiquity* has shown that it is possible to maintain a high level of scientific interest with a style and form which will appeal to the average educated reader. In the current number, the editor takes advantage of the fact that his editorial notes are written in an oasis of southern Tunisia to discuss the possible relation of the type of dwelling of the troglodytes of the Matmata hills, twenty-seven miles south of Gabes, of which the unit is the single cave room, with the cave dwellers of palæolithic times and the megalithic temples of Malta. Mr. Crawford contributes an article on "Historical Cycles", and Prof. Elliot Smith deals with the discovery of primitive man in China. Prof. Gordon Childe reviews the results of four years' excavation at Skara Brae, Orkney, for which he inclines to a Bronze Age date. Mr. Stuart Piggott discusses the possible origin of the Uffington White horse, on the basis of an interesting comparison with the horse design of early Iron Age coinage. Mr. C. Hawkes's paper on hill-forts, based on evidence from such as have been examined, is a pregnant study of distribution, which illustrates both by its inclusions and its omissions the comments in our issue of Mar. 21, p. 429, on the need of an archæological survey in Great Britain and co-ordination and co-operation in future research.

SINCE 1874 the State of Illinois, U.S.A., has carried on a State Laboratory of Natural History, which in 1917 became merged with the State Entomologist's Office, to form the Natural History Survey Division. Many valuable papers have been published by the workers of the Survey and their predecessors, dealing in large part with the systematic characters of different groups in the fauna of the State. But more general papers, discussing, for example, the ecology of various types of country, have also appeared frequently in the series, and it is interesting to see that so long ago as 1880, Stephen A. Forbes, the present chief of the Survey, was writing "on some interactions of organisms", on the food of birds, on insectivorous beetles, and still earlier on the crustacea eaten by fishes. Since 1876, the *Bulletin* has been published, and now the Survey publishes a 29-page pamphlet containing a "Classified List of Publications", in which the titles of all papers and reports not out of print are arranged under subject and author headings. The endeavour of the State in publishing its reports is to increase and spread the knowledge of the plant and animal life of Illinois, and, with this end in view, the Survey is prepared to distribute its papers, so far as reprints are available, to organisations and individuals willing to use them to stimulate further interest in natural history as a feature of public education. Those interested should apply for the Classified List of Publications to the Chief, State Natural History Survey, Urbana, Illinois.

THE Lane Lectures on Experimental Pharmacology and Medicine for 1927 were to have been given by Prof. Rudolf Magnus, of the University of Utrecht, but his untimely death that year prevented the fulfilment of this plan. Three of the five lectures con-

templated had, however, been completed, and these are now published under the editorship of Prof. P. J. Hanzlik in the Publications of Stanford University, California (Medical Sciences, vol. 2, No. 3: 1930). The lectures are entitled: "A Contribution to the Experimental Pathology of the Lungs", "Choline as an Intestinal Hormone", and "The Physiological 'A priori'", and deal with certain aspects of physiology in which Prof. Magnus was interested and had carried out investigations. The monograph, however, contains, in addition, a biographical note by Dr. H. H. Dale and a list of Prof. Magnus's works, compiled by Dr. A. de Kleijn, which considerably enhance its value. Prof. Magnus will be remembered chiefly for two investigations: the first, carried out at Heidelberg, showed that the smooth muscle coats of the intestine retained their vitality and many of their activities when the organ was suspended in warm oxygenated Ringer-Locke solution: the second, carried out at Utrecht and occupying the greater part of his eighteen years at this University, on the factors controlling the changes of animal posture. This work was published a few years ago in the great monograph, "Körperstellung". But the bibliography shows that his interest in pharmacological problems continued throughout, and in fact two of them formed the subject of the Lane lectures.

THE diagnostic and therapeutic uses of the applications of electricity in medicine and surgery are continually growing in value. It is only recently that any attempt has been made to rationalise the electrical apparatus used in accordance with electrical engineering standards. We consider, therefore, that the paper on the medical and surgical application of electricity read by Dr. Bernard Leggatt to various centres of the Institution of Electrical Engineers and published in the February *Journal* will prove very helpful. He considers that the great value of this branch of electricity is not generally recognised in Great Britain. In the diagnosis of disease, the combined services of the pathologist and radiologist are responsible for about 95 per cent of all positive diagnoses; hence it is surprising that on most hospital staffs these two specialists are not considered of sufficient importance to have seats on the hospital medical committee. The applications of X-rays, which present the widest field at present both for diagnosis and the treatment of specific diseases, are discussed at length. Great differences of opinion exist as to the relative value of gas and electron X-ray tubes. These differences are easily explicable, when we consider the physics of the problem. Any dangerous electrical apparatus can be installed in a hospital without supervision and operated by persons entirely ignorant of electricity, as, unlike workshops and factories, there are no Home Office regulations applicable. The best methods of producing ultra-violet radiation and of measuring its dosage are described. The use of high frequency currents to heat the tissues of the body to any desired degree is favourably commented on, and also the uses of the electrocardiograph. Some of the electrical treatments which have been suggested and are sometimes employed are of questionable value.

THE Report on the Investigation of Atmospheric Pollution in the year ending Mar. 31, 1930, issued by the Department of Scientific and Industrial Research, is a quarto pamphlet of 74 pages and costs 4*s*. (London: H.M. Stationery Office). According to it, the average amount of solid matter washed out of the atmosphere by the rain, at the 70 stations where observations are made, is slightly less than last year, but at 5 of them (in Burnley, Liverpool, Newcastle-on-Tyne, Rochdale, and Rotherham) it still exceeds 760 tons per square mile per annum, while very few get less than 100 tons per square mile per annum. When there is no rain to wash it out, this matter is present in the atmosphere at the rate of 1 or 2 milligrams per cubic metre of air, and may be carried down the wind for many miles. In London and Glasgow, domestic fires account on the average for 75 per cent and industries for 25 per cent of this solid material. While in the air, it obstructs the passage of light and particularly of ultra-violet light, and the observations at Rochdale show that 29 per cent of the ultra-violet light which reaches the outskirts of the town, where the pollution is less, is lost at the centre of the town, where the pollution is greater.

A CHEMICAL library of historic interest has just been discovered in the Bodleian Library by Dr. R. T. Gunther, who has published a list of twenty-three of the books in the recent issue of the *Bodleian Quarterly Record*. The greater number of the volumes now described were given, in 1683, by various benefactors to form the nucleus of a departmental library when the Ashmolean Chemical Laboratory was opened, as described in NATURE for April 2, 1927. The existence of this venerable collection of books, the oldest public chemical library in Britain, had long been forgotten owing to loss and dispersal of its volumes to fill gaps in the series of Ashmolean manuscripts, with which it had nothing to do. Fortunately, the names of donors have been inscribed in several of the books, thus establishing their identify. The more important gifts came from the vice-chancellor, the dean and other members of Christ Church, from Dr. Plot, the first professor of chemistry, and from John Cross, the 'privileged' apothecary at whose premises, in the Oxford High Street, Boyle and Hooke conducted their epoch-making researches in 'pneumaticks'. None of the books is recorded as having been presented by Ashmole, although he was the founder of the professorship of chemistry.

IN connexion with the total solar eclipse on Aug. 31, 1932, which will be visible in Canada and the United States of America, it is hoped to organise two tours from Great Britain. Tour 'A' will leave on or about July 22, and, after landing at Montreal, will proceed to Victoria, B.C., by the Canadian Pacific Railway. The return journey will be through North America, arriving at Boston on or about Aug. 30. All the more important observatories will be visited. Tour 'B'

will leave on or about Aug. 12, and will not be such an extensive one, but will arrive at Boston about the same time as tour 'A'. A joint attraction is the meeting of the International Astronomical Union under the presidency of Sir Frank Dyson, the Astronomer-Royal, which will be held at Harvard as soon after the eclipse as possible. Members of either tour may have their ocean tickets made available for return directly after the eclipse or after the meeting of the I.A.U. Further information may be obtained from the Assistant Secretary, Royal Astronomical Society, Burlington House, London W.1.

THE tenth anniversary of the founding of the first birth-control clinic by Dr. Marie Stopes was celebrated by a dinner at the Ritz Hotel on Mar. 17, when a distinguished company assembled to congratulate her upon the success of her campaign. Since the opening of the clinic, direct personal instruction has been given through lady doctors and midwives to more than twelve thousand cases, mostly very poor women, who have attended for advice and help. Travelling clinics have been initiated which have done valuable service in South Wales and the industrial north. It is important to remember that Dr. Marie Stopes' society exists for "constructive birth control", and that therefore it is concerned with the positive control of conception and the production of desired children as well as the prevention of childbirth by contraceptive methods. Information as to membership may be obtained from the Secretary, C.B.C., 108 Whitfield Street, London, W.1.

AN earthquake of moderate intensity was recorded at Kew Observatory at 8 h. 16 m. 38 s. G.M.T. on Mar. 18. The epicentre is estimated to have been 7340 miles away. The readings obtained at Kew, Fordham (North America), and Pasadena indicate that the epicentre of the shock was near lat. 34° S., long. 71° W., that is, near Santiago de Chili. A moderate earthquake was also recorded at Kew Observatory at 6 h. 38 m. 31 s. G.M.T. on Mar. 19. The epicentre is estimated to have been 6080 miles away, but the initial impulse was too small to give any indication of the direction.

BY the will of Mr. Montague Napier, one of the pioneers of the motor-car and aeroplane engine industry, cancer research will eventually benefit to a considerable extent. After several bequests have been made, the residue of the estate is left, subject to a life interest, "for the advancement of knowledge and the benefit of mankind by research, whether in the United Kingdom or abroad, with the object of ascertaining the cause of cancer (including corresponding or allied diseases) and the means of its prevention, cure, and alleviation, in the discretion of his trustees." The amount available for charitable purposes is expected to be about £700,000.

A SPECIAL exhibition of apparatus and equipment used in geophysical surveys was opened in the Science Museum, South Kensington, on Mar. 21, and will remain on view for a period of three months. The exhibits have been specially selected to illustrate the development of all the important methods at present employed in the location of mineral deposits by the use of sensitive physical apparatus, as well as the evolution of the instruments and apparatus used. Details of field operations and the technique of the various methods are also represented, while in addition many examples are shown of results obtained by geophysical surveys in various parts of the world. Several of these results, which are now made public for the first time, demonstrate, in a striking manner, the possibilities of geophysical methods of exploration, in revealing the characteristic features of subterranean structures and mineral deposits.

AT the stated general meeting of the Royal Irish Academy held in Dublin, Dr. R. Lloyd Praeger was elected president in succession to Prof. R. A. S. Macalister. The following officers were also elected: Treasurer, Mr. F. E. Hackett; secretary and secretary to the Science Committee, Prof. J. J. Nolan; secretary to the Polite Literature and Antiquities Committee, Mr. T. P. Le Fanu; librarian, Dr. E. J. Gwynn; resident secretary, Mr. A. Farrington. New members elected included Mr. T. S. Broderick, lecturer in mathematics and statistics, Trinity College, Dublin; Prof. T. Dillon, professor of chemistry in University College, Galway; Rev. H. V. Gill, *S.J.*, author of numerous papers on physics and geophysics; Dr. J. H. J. Poole, lecturer in physics in Trinity College, Dublin. Elections to honorary membership included Prof. Erwin Schrödinger, Berlin, distinguished for his work in theoretical physics; and Prof. Ludwig Diels, Berlin, for his eminent work in systematic botany.

A USEFUL catalogue of books in a new condition, on all branches of chemistry has just been issued by Messrs. H. K. Lewis and Co., Ltd., 136 Gower Street, W.C.1. Being carefully classified, it should be of service for reference purposes.

LIBRARIANS and others wishing to add to their store of scientific periodicals or to fill up gaps in those upon their shelves should obtain a copy of *Periodica*, New Series, No. 4, just circulated by Messrs. W. Dawson and Sons, Ltd., Cannon House, Pilgrim Street, E.C.4, in which upwards of 700 scientific serials are listed.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A whole-time instructor of metalwork at the Shoreditch Technical Institute—The Education Officer (T.1), County Hall, S.E.1 (April 1). An agricultural inspector under the Department of Agriculture for Scotland—The Establishment Officer, Department of Agriculture for Scotland, Queen Street, Edinburgh (April 7). A lecturer in geography at the University College of Swansea—The Registrar, University College, Singleton Park, Swansea (April 11). A science master at the Royal Naval College, Dartmouth—The Headmaster, Royal Naval College, Dartmouth (April 13). A superintendent of instruc-

tion in the principles of boot and shoe manufacture under the Northamptonshire County Council Education Committee—The Secretary for Education, County Education Offices, Northampton (April 13). A Dickinson research travelling scholar in medicine, and a Dickinson research surgery scholar at the Manchester Royal Infirmary—The Secretary to the Trustees, Royal Infirmary, Manchester (April 18). An assistant lecturer in geology at the University College of Swansea—The Registrar, University College, Singleton Park, Swansea (April 18). A lecturer in physiology in the University of Bristol—The Secretary and Acting Registrar, The University, Bristol (April 24). An assistant lecturer in education at the University College of Hull—The Registrar, University College, Hull (May 6). An assistant lecturer in geography at the University College of Hull—The Registrar, University College, Hull (May 9). A professor of chemistry in the University of Sheffield—The Registrar, The University, Sheffield (May 15). A Pilkington fellow in cancer research, an Amy Henrietta Worswick fellow for the investigation of the causes and treatment of rheumatoid arthritis, and a Knight fellow for the study of the factors concerned in the development of the symptoms of mental disturbance, in the University of Manchester—The Registrar, The University, Manchester (June 1). A temporary lecturer in educational psychology and hygiene at Goldsmiths' College—The Warden, Goldsmiths' College, New Cross, S.E.14. A research fellow at the Liverpool and District Hospital for Diseases of the Heart—The Secretary, Heart Hospital, Oxford Street, Liverpool. A junior chemist at the Rubber Research Institute of Malaya—The Secretary, London Advisory Committee, 2 Idol Lane, Eastcheap, E.C.3.

Our Astronomical Column.

Total Eclipse of the Moon.—It is several years since a total eclipse of the moon has been visible under favourable conditions in the British Isles. Advantage should therefore be taken of the occasion on April 2, though the moon's altitude will not be great. In London, the sun sets at 6.33 P.M., the first contact with the umbra having occurred 10 minutes earlier; totality begins at 7.22, and lasts for 1½ hours; the last contact with the umbra is at 9.52.

Observations of occultations of faint stars during totality can be utilised for obtaining improved values of the moon's diameter and parallax; also studies of the colours and degrees of brightness of various regions of the moon's disc enable inferences to be drawn as to the transparency of the earth's atmosphere in the regions where the moon is on the horizon. Mr. L. Richardson contributed several papers to the B.A.A. *Journal* on this subject; he showed that it is only the lower layers of the earth's atmosphere that are effective in refracting light to the central regions of the umbra.

Who discovered Jupiter's Satellites?—J. H. Johnson, in the B.A.A. *Journal* for January, vindicates the claim of Simon Mayer to have discovered the four great satellites of Jupiter some days before Galileo, and to have deduced better values of their distances from Jupiter and their periods than those of Galileo. He gives long quotations from the original documents, and refers to J. Bosscha's paper in *Archives Néerlandaises des Sciences*, 1907. Galileo himself denounced Mayer; but his attacks appear to have been unjust, and a good deal of evidence is given in the paper that Mayer's work was independent. His values for the diameter of Jupiter and the radii of the satellite orbits suggest that his telescope gave better definition than Galileo's did. He received two excellent lenses made by John Baptist Lenccius, of Venice, early in 1610; but he had observed the satellites with another telescope in December 1609. In explanation of the fact that neither he nor Galileo noticed satellite IV. on Jan. 8, 1610, it is pointed out that it was then at elongation, far outside the other satellites, and that there were other stars of similar brightness near it. Mayer was the first to publish tables of the satellites. Bakhuyzen has shown that a fixed star which Mayer inserted in a sketch taken on Dec. 30, 1610, is in the right place; this adds weight to the genuineness of Mayer's observations. Most modern works continue to give Galileo's name as the sole discoverer, so it is well to direct attention to Mayer's claims.

Eros.—Signor L. Jacchia, of Bologna, discusses the light-variation of Eros in *Astr. Nach.*, 5761. He finds for the period of variation 0·10973 days; most observers consider that the true period is twice as long, being formed of two waves that are similar to each other but not quite identical. The magnitude at minimum changed from 12·04 on Oct. 27 to 10·96 on Nov. 23. The amplitude of the light-variation is given as 1·12 magnitude on Oct. 22; 1·08 magnitude on Nov. 12; 1.26 on Nov. 23.

Report of the Naval Observatory, Washington, for 1930.—Details are given concerning the sending and reception of wireless time-signals. The maximum error of the Annapolis signal was 0·21 sec., the average error 0·038 sec. The signals from Rugby and Bordeaux were received on most days.

The Nautical Almanac for 1933 is practically completed. The list of stars with ephemerides has been increased by 36. A new star catalogue is being formed from 72,330 observations made with the 9-inch transit circle between 1913 and 1926. A table comparing the mean declinations of fundamental stars in different zones with those in various standard catalogues is given in the report. The 26-inch equatorial was used for observing the satellites of Jupiter and Saturn, also comets, minor planets, and occultations of stars by the moon. Photography of the sun was continued; photographs were secured on 308 days, which is a record number. The connexion of sunspots with magnetic disturbances and radio transmission is being investigated. Predictions of magnetic storms have been occasionally issued by post card. An expedition was sent from the observatory to Honey Lake, Calif., for the eclipse of April 28, 1930. The corona could not be photographed; but the position of the central line was fixed, and found to be very close to the predicted one. A collection of 625 books belonging to Prof. Asaph Hall, jun., was presented by his widow to the observatory.

Visitors are admitted to the observatory on Thursday evenings; 2824 visitors came during 1930 and they were shown objects of interest with the 12-inch equatorial.

Research Items.

Population and Immigration.—In 1751, Benjamin Franklin wrote his "Observations Concerning the Increase of Mankind and the Peopling of Countries" and concluded that the importation of foreigners into a country does not necessarily increase the population; but that if the immigrants are more industrious and frugal "they will gradually eat the natives out". This thesis is supported by W. A. Rollins (*Jour. of Heredity*, vol. 21, No. 9), who analyses the census changes in the United States since 1650 and their relation to immigration. He shows how the originally high fertility of the early colonial stock declined very slowly until about 1850, when there was a great increase of immigrants, after which the decline was rapid. He also shows that for different parts of the country a high rate of immigration coincided with a low birth-rate and vice versa, and that while the immigrants have been chiefly labourers, the fall in the birth-rate has been most marked among university graduates, the ultimate effect being the replacement of the educated stocks by immigrants and their descendants. The character of the population of New England has been deteriorating in this way at least since 1850 and probably earlier, and the author suggests that the cycles of civilisation are sometimes correlated with a differential birth-rate, the ascent taking place during a period when superior stocks have more children than inferior ones.

Mound Burial, Beech Bottom, Ohio.—The excavation of a small mound on the Ohio River in July-August 1930 is recorded by Charles Bache and Linton Satterthwaite, jun., in the *Museum Journal* (Philadelphia), vol. 21, Nos. 3-4 (Sept.-Dec. 1930). The mound was found to contain a grave in which was a skeleton richly decorated with shell and copper beads. Objects in considerable numbers were found in the sand thrown from the grave and the dark earth which had been used to fill it. Stone objects for the most part were of flint or flinty material, in number 116, of which 70 were thin blades, stemmed or leaf-shaped, averaging about 10 cm. in length. The remainder were small points and scrapers. More remarkable was the persistent occurrence of tubes, all, with one exception, of grey pipestone. Thirty-two were found. Of these, seven were complete, two being entirely unbroken. The lengths ranged from 10·8 cm. to 31 cm., the maximum diameter being 2·3-3·8 cm. Ten celts were found, some of hæmatite. Tubes similar to those found here have been found but rarely, especially of such size and in such number. Various uses have been suggested, such as shaman's blowing or sucking tubes, whistles, and so forth, but there has been some disinclination to regard them as smoking-pipes. In two, a clay and a charcoal pellet were discovered. In similar cases elsewhere it has been suggested that these were intended to keep the liquid generated in smoking from the mouth. The breaking of the tubes had taken place prior to excavation, and, it is believed, was intentional for ritual purposes. It is suggested that the mound belongs to the Adena culture of the Ohio area. This culture is little known and is only now beginning to be defined. Its chief characteristics are small conical mounds, singly or in groups; uncremated burials in log cists; the use of copper, mainly as ornament; the use of mica, sculpture in the round, and the use of tubular tobacco pipes. The culture is linked with the little-known culture of the Kanawha Valley, West Virginia.

Pearl Fisheries of Sulu.—Florencio Talavera in a paper published in the *Philippine Journal of Science* (vol. 43, No. 4; 1930) has brought together much information on the present situation of the pearl fishery in the Sulu Archipelago. This is a large natural pearling ground, the largest and most prolific in the Philippines, bounded by the Sulu Sea on the north and the Celebes Sea on the south and east, extending for 137 miles in a south-westerly direction from Basilan to Borneo, and consisting of two main groups of islands divided into many smaller islands, islets, and reefs. In the deep water, there are 'pockets' or pearl beds that serve as natural nurseries from which millions of eggs are produced and scattered by the currents, and these settle on the shallow banks. This constant supply is apparently the explanation of the fact that the pearl beds have not been depleted after many years of fishing. The north-east and south-west monsoons naturally regulate the fishing, bringing about a rotation in the working. The Philippine pearl oyster *Margaritifera maxima* grows rapidly, for there are no cold spells to retard its growth. It is sexually mature in two years and attains 14 cm. "nacre measurement", the "present legal size", in about three or four years. It is recommended that this minimum legal size be altered to an outside measurement, as it is difficult to measure accurately the extent of the nacre, and that the Departmental order which restricts the fishing to certain times be rescinded. The present fleet is apparently too small to do any serious damage to the fisheries, and the pearling boats do not as a rule work on the known grounds only but do a considerable amount of prospecting, new beds being discovered continually. It is also recommended "that no protective measures for all beds or any banks within the Sulu Archipelago be adopted until after a careful study of the fisheries shall have been made".

A Study of Mangrove Crabs.—Dr. J. Verwey has done a most valuable piece of work which is described fully in his paper "Einiger über die Biologie Ostendischer Mangrove-Krabben" (*Treubia*, vol. 12, 2; 1930). The fauna of a mangrove swamp is peculiarly specialised and the crabs live in and out of the slimy mud, each species in its own zone and each individual in its own territory. Notes on the mollusca of the different zones are also given, but the main part of the work is on crabs, especially *Uca signatus*. The genera *Sesarma*, *Metaplax*, *Ilioplax*, and *Scylla* are all represented. The account of their habits and their adaptation to the environment is specially interesting. Five zones are recognised, each zone inhabited by different crabs and molluscs which have certain characteristics in common. They are able to withstand much change of salinity; most of them eat the slime and extract nutriment from it, chiefly minute plants and animals; many of them are amphibious, breathing either by gills or by lungs; all of them dig burrows, of various depths, which reach the underlying water. The peculiar habit in fiddler crabs of waving the large claw is believed by the author to be a demonstration of territorial rights, and not, as is sometimes thought, a calling to the female. It apparently goes on almost continuously. The habit appears to belong only to those species which live very close together, with their burrows adjacent, each feeding on the slimy mud around its own special home. The paper is illustrated by clear diagrams of the burrows, text figures of the crabs and their appendages, and beautiful photographs showing the various habitats.

The Reproduction of *Polystomella*.—We have to thank Mr. E. Heron-Allen, for the publication of the original notes of Dr. J. J. Lister on the reproductive

processes in *Polystomella crispa* (*Smithsonian Miscellaneous Collections*, Publication No. 3067. Volume 82, No. 9; 1930). Dr. Lister's work on the reproduction of the megalospheric form of *Polystomella* by means of flagellispores has been familiar to zoologists for more than thirty years, and it was also known that he had completed the study of the microspheric form, but although the gist of this work had been published, the actual paper had never appeared. This unpublished paper was found after Dr. Lister's death and completed and edited from his note-books by his friend Mr. Heron-Allen. In 1894 the paper on the megalospheric form was published in the *Philosophical Transactions* of the Royal Society. The later work on the microspheric form was only published as a postscript to the earlier paper, and this postscript, slightly elaborated, appeared in his "Foraminifera" in Lankester's "Treatise on Zoology" in 1903, in his presidential address to Section D (Zoology) at the York meeting of the British Association in 1906, and in his evening discourse at the Royal Institution in 1907. The protoplasm of the microspheric form of *Polystomella* emerges from the shell and breaks up into small spheres, each of which becomes a megalosphere. Details of the process will be found in these notes, with very beautiful photomicrographs published now for the first time. The whole of the note-books, slides, and photographs have been presented by Mrs. Lister to the Heron-Allen and Earland Library and Collection at the Natural History Museum, London.

Stalked Buds in the Coral *Echinopora*. — Dr. H. Boschma and Dr. J. Verwey, in their paper "The Occurrence of Stalked Buds in the Coral *Echinopora lamellosa*, Esper" (*Treubia*, vol. 12, 2, Oct. 1930), describe the frequent presence of small stalked corallites on the under-side of colonies which are partly exposed to light. These have been noticed before by Dr. Boschma in specimens from a small island in Sunda Strait, but they are now found to be common in the colonies of *Echinopora* in the reefs of the Thousand Islands (especially those of the Bay of Batavia). These corals occur both in sheltered and exposed situations, their form differing in different habitats. The principal factor governing the development of these stalked buds appears to be light, but the corallum must have a certain thickness before the buds are formed. The paper is illustrated by interesting photographs.

Changes in the Proteins of Ripening Rice Grains.—Takadoro and Abe (*Jour. Faculty Agric., Hokkaido Imp. Univ.*, **27**, 349) record a large number of changes in the composition of rice grains during the last three weeks of their development. If correct, some of these are of a fundamental nature, for a study of the nitrogen distribution in the protein extracted as oryzenin shows striking changes during ripening. While histidin nitrogen was found to increase progressively, most of the other nitrogen fractions show a maximum or a minimum about ten days before the grains ripen. Amide nitrogen, monoamino nitrogen, and particularly cystine nitrogen fall to a minimum at this time. Diamino nitrogen, however, shows a maximum, apparently due chiefly to a maximum of arganine. In the same way, there is a minimum of ash and of phosphorus, but, curiously enough, a maximum of sulphur in spite of the low cystine. The isoelectric point of oryzenin fluctuates in accordance with these changes from *p*H 4·75 to *p*H 5·08, being highest when the diamino nitrogen is at a maximum.

The Estuary of the Sussex Ouse.—Using both physical evidence on the ground and documentary evidence from old maps and descriptions, F. G. Morris has traced the changes in the mouth of the Sussex Ouse and the effect of these changes in the destinies of the towns of Seaford and Newhaven. The account appears in *Geography* for March, and is a useful record to the history of changes in the English coast-line. In the thirteenth century and probably earlier, Seaford was a port of considerable importance lying in the estuary of the Ouse about a mile north-west of Seaford Head. The sea did not then reach the chalk spurs of Blatchington and Hawth Hills, which had the river at their feet, separated from the sea by a broad shingle spit that no doubt had been piled up by westerly winds and diverted the river mouth to the east. This shingle spit was breached in the sixteenth century and a new river-mouth resulted on the site of Tide Mills, which became Newhaven. Thus the old port of Seaford was rendered valueless and in time silted up. The present outlet of the Ouse dates from the seventeenth century and would appear to be partly artificial. Near the mouth was the port of Meeching, which eventually became Newhaven when the original port of that name was rendered valueless by shingle drift and was abandoned. The old course of the Ouse is now represented in part by Mill Creek.

Excitation of Zinc and Cadmium Spectra.—A very full study of the intensity of lines in the spectra of cadmium and zinc when excited by electrons of a definite speed is described by K. Larché in the *Zeitschrift für Physik* for Feb. 6. The excitation functions, which vary for different types of transitions in the way referred to by Mr. Massey and Mr. Mohr in their recent communication to NATURE (Feb. 14, p. 234), also agree very well with those previously found for the allied spectra of mercury. Perhaps the remaining point of least definiteness now is the existence of more than one maximum in the excitation curves for certain lines. There is a doubt as to whether this is essentially an atomic phenomenon, or due to the conditions in the discharge tube. The results of different observers are not always consistent, and in one case, that of the negative bands of nitrogen, a triple maximum has been reported. Dr. Larché believes that there is a relation between the sharpness of the maximum in the excitation curves and the average life-time of the atom in the excited state from which the transition starts—a long-lived atom appears to have a sharp excitation function, and an atom with a short life an excitation function with a less pronounced maximum—and in one case, that of the $1^1S_0 - 2^1P_1$ resonance line of cadmium (2288 A.), points out that the double maximum of the excitation function has its counterpart in the existence of two different values for the life-time.

Inductance Coefficients in Electrical Engineering.—In electrical engineering, very considerable use has been made of inductance coefficients in connexion with distributing mains, since Maxwell and Lord Rayleigh first gave the requisite formulæ. Recently, in everyday work, it has been customary to compute the inductance coefficients for parts of a circuit. The assumption is frequently made that there is a coefficient of 'mutual' inductance connecting these partial coefficients. In the February issue of the *Journal* of the Institution of Electrical Engineers, Dr. A. Russell points out that this is not the case and gives the requisite formulæ. He also lays stress on the limitations of these formulæ in practical work, as most of them depend on the assumption that the current density is uniform over the cross section of the cable. With high frequency currents this assumption is not permissible, the current distributing itself

in such a way that no magnetic effect is produced in the metal of the conductor. This he calls the 'Heaviside' effect. He proves that although sheath losses can be computed in certain cases by means of inductance coefficients, the method fails when the sheath surrounds two or more cores carrying polyphase currents. In this case, the instantaneous value of the algebraical sum of the currents flowing through a cross section of the sheath may be zero. This shows that some of the currents in the cross section are flowing in one direction and some in the other. The current density varies both in magnitude and phase as we go round the cross section. Many new formulæ are given and some of the old ones are given in forms more convenient for computation.

A Neon-tube High Tension Voltmeter.—The difficulties that have been experienced in devising voltmeters which will read pressures of 100 kilovolts and upwards have led designers to invent instruments which depend on the distance between spherical electrodes when sparking occurs to give an indication of the voltage. Corrections for temperature and pressure have to be employed, and the voltage found is the crest or maximum voltage. The effective voltage required in practice can only be known when the law according to which the voltage varies has been determined. In many cases, however, especially with modern generators, the assumption that the voltage follows the harmonic law suffices, and so we can deduce the effective voltage from the crest voltage by dividing it by the square root of two. Dr. L. E. Ryall read a useful paper to the Institution of Electrical Engineers on Feb. 6, on the use of a neon tube as a high tension crest voltmeter. The accuracy of the method depends in a large degree on the constancy of the striking voltage of the neon lamp when arranged as a voltmeter. To test the lamp, it is made part of a neon-tube oscillator consisting of a variable air condenser (0·001 μF max.) in series with a resistance of one megohm and a telephone receiver across a direct current supply of 400 volts. The lamp is in parallel with the condenser, and the capacitance of the latter is reduced until oscillations cease. It is found that, if the lamp has permanent characteristics, the frequency of the oscillations can be increased above the audio range (about 20 kilocycles per second) and the capacitance can be reduced to less than 50 $\mu\mu F$ before oscillations cease. When this occurs, there is a sudden change in the appearance of the glow. By subdividing the voltage by a condenser divider, it was found that the tube could be used very satisfactorily as a sub-standard voltmeter.

Liquid Diffusion.—The January number of the *Journal of the American Chemical Society* contains a paper by McBain and Tsun Hsien Liu on the diffusion of electrolytes, non-electrolytes, and colloidal electrolytes. The authors combine the Nernst formula for the diffusion of an electrolyte with that of Einstein for uncharged spherical particles or molecules very large in comparison with those of water, and conclude that a generalised equation for the diffusion coefficient, D, will be $D = iRT/\Sigma(1/U_m)$, where $1/U$ is the resistance to movement of a particular species, iRT being the osmotic term. The apparatus used was a Northrop diffusion cell with a diaphragm of sintered glass, and the experiments were very rapid and reproducible. For simple electrolytes, the predominant factor is the van 't Hoff factor i, the data for potassium chloride being reproduced to within 2 per cent by the formula when i varied whilst the denominator remained constant. This implies incomplete ionisation. As an example of the method of summation of the effects due to different constituents in predicting total diffusion, the data for a typical soap solution were analysed and found to be in agreement with previous information. The data for sugar solutions show that the viscosity contributed by the dissolved substance is not that which determines rate of diffusion. The diffusion column of one substance may, by bombardment of its molecules, accelerate, retard, or even reverse the diffusion of another substance.

Ortho-hydroxy Aldehydes.—Malkin and Nierenstein in the January number of the *Journal of the American Chemical Society* describe some experiments on the acetylation of phloroglucin aldehyde which are of importance in connexion with the synthesis of flavylium compounds. It was known that the usual coumarin reaction does not proceed when phloroglucin aldehyde is heated with acetic anhydride and anhydrous sodium acetate, the product of condensation consisting mainly of 2, 4, 6-triacetoxybenzylidenediacetate, melting at 155°-156°. Pratt and Robinson, and Robertson and Robinson, by the action of phloroglucin aldehyde and acetic anhydride, in the presence of potassium carbonate, obtained a substance, melting at 156°-157°, which they considered to be triacetylphloroglucin aldehyde. The analysis did not agree well with the formula of this substance, so that the presence of half a molecule of combined water was assumed. Malkin and Nierenstein show that this so-called triacetylphloroglucin aldehyde is the penta-acetate compound prepared in 1903 by Herzig and Wenzel, and that the true triacetyl compound may be obtained by carrying out the acetylation in ether solution with acetic anhydride and potassium carbonate. The material obtained by Robinson and Robertson has been the starting material in the synthesis of a large number of anthocyanidins.

Constituents of Starch.—The work of Maquenne and Roux supports the conclusion that natural starch is made up of two constituents, namely, insoluble amylopectin, which is responsible for the paste-forming properties, and soluble amylose ('artificial starch'), in the proportions of 80 and 20 per cent respectively. Effront has recently attacked certain of their hypotheses (*Ann. Soc. Zymol. pure et appliquée*, **2**, 5; 1930) showing that amylose has the properties of a polysaccharide of the type $(C_6H_{10}O_5)_{12} \cdot H_2O$ and that it probably results from the hydrolysis of depolymerised starch, and cannot, therefore, be a mixture of reducing sugars with dextrins. Amylopectin is characterised by the presence of phosphorus, probably in an ester combination, though the actual nature of the compound in which it is present may vary and produce corresponding variations in the power of gelatinisation of the starch. Analogously, the amount of phosphorus present determines the solubility of the amylopectin. The author goes so far as to suggest that differences in the properties of these two constituents of starch are due to differences in their physical as distinct from their chemical states. The work of Nowopokrowsky and Tschebotarewa (*Kolloid Zeit.*, **52**, 302; 1930) supports the existence of these two substances, though the properties described are not in complete agreement with those observed by other workers. These authors explain gelatinisation by the production of a concentrated solution of amylose inside the starch granules, followed by a contraction of the outer skin of amylopectin. These papers illustrate the great difficulty, characteristic of studies on starch, in correlating results of different workers who approach the problem from different points and give the same names to substances which are not necessarily identical.

The Relation of the Fauna and Flora of the British Isles to those of North America.

AT the Linnean Society on Mar. 5, Mr. H. E. Forrest opened a discussion on "The Relation of the Fauna and Flora of the British Isles to those of North America". Mr. Forrest first summarised the geological evidence on which his hypothesis is based. There were two phases of the Great Ice Age: (1) Ice-sheet period; (2) glacier period. During the first phase the ice came from north-west across the Irish Sea; during the second phase it came from the north-east.

(1) The ice-sheet originated in the mountainous northern region of the Atlantean continent, which connected Europe with North America. This gradually sank. Eventually an arm of the sea intruded between the Faroes and Scotland: this broke the continuity of the ice-sheet and brought it to a standstill.

(2) When the ice-sheet became stationary, its south-easterly thrust ceased. Then the local glaciers had free play. The Scottish Highlands and the Lake District produced glaciers on a big scale, and these sent forth streams of boulders which spread out west and south-west to Ireland, North Wales, and the plain of Cheshire and northern Shropshire. The glaciers lasted after the ice-sheet had finally melted and gradually retired as the climate ameliorated.

In the course of his investigations into the mammalian fauna of the British Isles, Mr. Forrest has found that out of sixty-four British species—recent and fossil—thirty-two are absent from Ireland. The usual explanation is that these reached Britain after Ireland became an island. But in the west of Ireland there are many plants and animals which do not occur in Britain. Several—such as *Saxifraga umbrosa*—occur only in Spain and western Ireland.

Among all classes of animals and plants, many species are common to eastern North America and western Europe. Five-sixths of American fungi are also British. About a hundred phanerogams, including many fresh-water plants, have similar distribution; whilst among invertebrates—especially insects and molluscs—examples are numerous.

That there was a land-bridge between Europe and America in the north is admitted. Evidence was offered that there was also a connexion in temperate latitudes; that in place of the North Atlantic there was an Atlantean continent—the northern half mountainous, the southern a plain with great fresh-water lakes. Mr. Forrest suggests that this continent was the home of all British-American species, and that some of them originated in it. *Saxifraga umbrosa* undoubtedly did so, and other species classed as Lusitanian by Dr. Scharff. He also suggests that the Salmonid fishes, including *Coregonus* and *Salvelinus*, and the crustaceans *Mysis* and *Limnocalanus*, originated in the Atlantean Lakes.

Dr. C. Tate Regan said that the examples given to support the hypothesis of an Atlantean continent are just as well explained by the supposition that the northern continents have occupied nearly the same areas since the Eocene, except for connexions between Asia and America across the Bering Sea, and possibly between Europe and America via Iceland. The only European species found in North America are northern types that range through Siberia, such as the pike. The Salmonids (char, whitefish) said by Mr. Forrest to have come from the Atlantic continent are not true fresh-water fishes. Char (*Savelinus*) are marine fishes that run up rivers to breed and form colonies in lakes: those of the lakes of Ireland and Britain may have entered them in glacial times when our seas were colder and the limit of char in the sea was farther south.

If in late Tertiary times the North Atlantic had been filled with a continent, one would expect nearly the same marine fauna on opposite sides of the Atlantic. It is only the northern species (cod, herring, etc.), found also in Iceland waters, that are common to America and Europe.

Dr. A. B. Rendle did not consider the existence of a North Atlantic continent necessary to explain the relations between the flora of the British Isles and North America. Existing land areas north of the Atlantic represented an adequate connexion between Europe and America in view of the more favourable conditions known to have prevailed formerly in Greenland. The presumed existence of the Atlantean continent suggested a greater similarity between the floras of eastern North America and south-west Europe and the Mediterranean than was borne out by facts. The Lusitanian element in the European flora finds a more satisfactory explanation as a European, not as an Atlantean outlier. Some of the species common to Europe and North America, such as *Pteris aquilina* and *Potamogeton natans*, adduced as evidence by Mr. Forrest, have a very wide distribution and have no bearing on the case. The distribution of *Eriocaulon septangulare* is remarkable, but it seems unnecessary to invoke an Atlantean continent to explain it.

Prof. J. W. Gregory was reminded by Mr. Forrest's North Atlantean ice-cap of the once assumed north polar ice-cap. If the glaciation of the British Isles was by ice from a North Atlantic continent, some of its rocks should be found in the British glacial drifts. In the absence of such material, the issue depends on the interesting cases of distribution to which Mr. Forrest had directed attention.

Mr. J. Ramsbottom said that Mr. Forrest's summary seemed to lay unwarranted stress on the distribution of fungi. The statement that five-sixths of American fungi were British was based on a list published by Mr. Carleton Rea and himself after a short visit to the eastern United States in 1926. The list included only larger fungi. If the whole continent were considered and all classes of fungi, the proportion would be entirely different. Parasitic fungi were largely specialised to their host plants and consequently could only be common to the two areas where the hosts were. The aquatic Saprolegniaceæ had many species in common but they were of world-wide distribution. The fact that the larger fungi of South Africa and other temperate regions have a large proportion of species in common suggests that fungi cannot be called in to give any support whatever to hypotheses of lost continents, and this is probably the same with all cryptogams having small spores.

Dr. O. Stapf observed that he could not adduce any evidence in favour of Mr. Forrest's views from the distribution of the so-called Lusitanian elements. The simultaneous occurrence of so many species in Europe and in North America is probably very largely connected with a more northern land connexion in Tertiary times, such as is very generally admitted. A certain percentage, however, may be due to simultaneous northward radiation to both hemispheres from an old common area in the south; for example, *Ericaulon septangulare* and *Brasenia purpurea*, the latter now extinct in Europe. There is evidence of an extension of the Lusitanian element along the

coast-line which connected Ireland and Scotland with Norway across what is now the North Sea. Along the same line northern elements spread southwards and have left relict stations so far south as Ireland, where they mingle with Lusitanian species in Clare Island, the cliffs of which harbour *Silene acaulis* and *Saxifraga hypnoides* in intimate contact. This coast is the most westerly extension of land in this part of the Atlantic which we can safely postulate. In dealing with such problems it is necessary to consider species not only in relation to their special distribution but also to those of their nearer and wider allies.

Dr. B. P. Uvarov stated that in studying zoogeographical problems it is necessary to apply ecological methods. Orthopterous insects are particularly suitable for these studies, because of the very small number of British species. Three zoogeographical groups may be distinguished amongst British Orthoptera. The largest consists of species distributed across Siberia, northern and middle Europe. This group originated in the Angara continent of geologists. Amongst members of the Angara fauna there are some which occur in North America but they spread via north-east Siberia. The second element is the Lusitanian (Atlantic); their present distribution points to their having originated in dry rocky land at the latitude of the Mediterranean Sea and Canary Islands. The third group belongs to families and genera now widely spread in the subtropics and tropics, and they are obviously relics of an age when the British Isles together with the most of the northern hemisphere enjoyed a mild tropical climate.

Mr. A. J. Wilmott emphasised the point that, with the possible exception of *Saxifraga Geum*, no species of the Lusitanian element of the British flora occurs in North America. These species must be relics in Ireland, since there has been no connexion southwards since the glaciation. Moreover, these species are not particularly cold-shy: they ascend to considerable elevations in Ireland. There are many species common to Europe and to North America, though the number is being steadily diminished by critical study. There are a number confined to Europe and eastern North America, and Prof. Fernald has found several restricted in America to the unglaciated parts of Newfoundland and the mouth of the St. Lawrence. We know that many species with limited distribution to-day formerly had a wider area of dispersal. There are species which are now known only in the eastern United States and Japan. It may therefore be possible that a species occurring only in Europe and the eastern States was originally connected across Asia and not across an Atlantis, and too definite an inference should not be drawn from present-day distribution alone. A proper analysis of the whole flora may give indications of the history of its development.

Dr. G. P. Bidder pointed out that the distribution of the fresh-water sponge *Heteromeyenia ryderi* given as western Ireland and eastern North America is from Hanitoch's list of Irish Fresh-water Sponges (1895), whereas the later account of Stephens shows that this is one of the commonest sponges of Ireland but restricted to non-calcareous districts and occurring in the island of Mull. Miss Stephens gives no opinion on the distribution of *H. repens*, which occurs in America over approximately the same area and has otherwise been recorded only from Galicia, though she holds that the distribution of *H. ryderi* supports Scharff's hypothesis of a land-bridge to America from Ireland.

Forestry in Kenya Colony.

IN the previous Annual Report of the Forest Department of Kenya Colony and Protectorate, reference was made to the great drought of 1928. The recently published report for the year ending Dec. 31, 1929, states that "the drought continued with ever-increasing intensity for the first quarter of the year", but long rains followed and recovery was rapid. One of the results of the drought was rather serious forest fires, occurring principally on the Aberdares and on the Mau. The other visitation with which the Colony was afflicted was a plague of locusts, which, says this report, "showed signs of having passed its peak and being rapidly on the decrease, and a greater spirit of optimism prevailed generally".

Steady progress is being made with the work of selecting new forests for reservation and with the survey of the reserved areas. It is pleasing to note that an earnest endeavour is being made to ascertain the degree of stocking in the various forests under exploitation by sawmills. Enumeration of growing stock is proceeding apace and two working plans are in operation. It had been proposed to form a special working plans party "but no staff was available during the year".

There are several forestry administrations under the Colonial Office to which similar remarks on the subject of inadequacy of staff are to be found in the annual reports. It is to be hoped, now that prospects in those forestry services are really attractive, that young men of the right type will come forward for training. For without sufficient and efficiently trained gazetted staffs real progress is impossible. Under Financial Results, the Conservator (Mr. H. M. Gardner) writes: "With only the comparatively small local market to depend on, it is not possible for the Department to produce a large net revenue. It can be considered distinctly satisfactory if the Department can pay its way while the forests are being explored, developed, and brought into a more productive state. As the forests are improved and communications become better, production costs will diminish, and it should be possible to develop much wider markets and to obtain a very handsome profit from the Colony's forests." The Conservator's optimism is probably quite justified; but it should be remembered that this will only be possible provided financial support is available to develop the forest estate.

As a case in point, the opinion of the Government of India at the time a forest organisation was being introduced into that country, soon after the inauguration (in 1864) of the Indian Forest Service, may be quoted; for its application to several of the colonial forest services may not be out of place. The following extract is from a Circular (Revenue—Forests, No. 24, dated 23rd November 1867) issued by the Governor-General, Sir John Lawrence, in Council, and forwarded with a covering dispatch to the Secretary of State for India. "It appears expedient to the Governor-General in Council, to state that there are certain cases in which the administration of forests must, like the Irrigation Department, undertake works of public utility the outlay on which, within one year, may not always be covered by the revenue of the year. The rule that the forest expenditure shall always be covered by the revenue can, in its very nature, only apply to ordinary expenditure."

On the plantation work in Kenya being carried out the report is most informative: 4000 acres were

undertaken during the year—the largest area so far accomplished in any one year; and this in spite of the fact that a large number of blanks, due to the drought of 1928, had to be filled up in the existing plantations before any new work could be commenced. This afforestation work is undertaken in several different ways. (1) The greater part of the plantations are made on land that has been clear-felled for timber and fuel and then cleaned up and cultivated by forest squatters. The work, in spite of difficulties, is cheap and efficient. The method is analogous to the *toungya* method employed in Burma and elsewhere in India. (2) When squatters are not available and when the Department is afforesting grasslands, the area is either ploughed and cultivated by contract or a small sum is paid for ploughing and the contractor is allowed to have the use of the land for two to three years before planting; or again, bush-covered land is being afforested by planting trees in lines cut through the bush, the growth being slower, but the bush acting as a nurse to the young trees and keeping down weed growth. Of the 4000 acres planted, 1063 acres were afforested by this method. This represents an addition to the Colony's forest capital. (3) In certain types of forest, for example, *Brachylæna*, *Ocotea*, and some *Podocarpus* forests, natural regeneration, with assistance, is sufficient to replace the timber cut. (4) Special attention is being concentrated upon fuel plantations and various exotics are being experimented with, and private planting is being encouraged. Both railway and public take large amounts of fuel; the former utilised from all sources, Government and private lands, 13,867,025 cub. feet during the year. As private resources are cut out, the demands will fall increasingly heavily on the Government forests. Fuel is now being supplied in large quantities from *Eucalyptus* plantations formed on the sites of natural forest cut for railway fuel. The demand for fuel for domestic and industrial purposes is increasing rapidly round Nairobi and is becoming more and more difficult to supply. In a few years, however, large areas of plantations will be maturing, as well as large plantations of black wattle, which is being planted on private land for the production of tanning bark.

Kenya is so much before the public at the present time that the operations of the Forestry Department, so far as they affect the future well-being of the Colony, appear to merit some prominence.

Marine Research in the Mediterranean.

THE fisheries of Egypt, though small in comparison with the vast fisheries of the northern waters of Europe, are varied and interesting. They comprise the sea fisheries along the northern coast of Africa in the Mediterranean, and in the Red Sea; the Nile and delta lake fisheries, the latter of which in 1928 supplied about three-quarters of the whole weight of fish landed in Egypt; and also the valuable sponge fisheries of the North African coast lying in territorial waters between Alexandria and Sollûm, which furnish sponges unrivalled in the world for their excellence of quality.

We have received the report of the fisheries for the year 1928,* and amongst other items of interest are given comparative figures of the yield in kilograms per unit area of fish from the delta lakes. These lakes are of exceptional interest, extending over huge areas and never exceeding much more than a metre in depth; they form a link between the Nile and the sea, for into their southern margins empty the drains of fresh water that have been drawn from the Nile to irrigate the land, while all but one are connected with the sea. The lakes are thus stocked both by fresh-water fish and by fish entering from the sea. By far the most important fish, however, are the grey mullet, which grow and flourish extremely well under the conditions existing in the lakes, and which, at certain periods of the year according to the species, leave on their spawning migrations for the sea. Figures are given to show that during the last eight years the average yield of fishes from lakes Menzaleh, Brullos, Maryût, and Edkou together amounted to so much as 142 kgm. per hectare. Parallel figures are given for the North Sea as 17·3 kgm. per hectare, and for cultivated carp ponds as 65·5-165 kgm. For a natural fishery these delta lakes are therefore extremely rich.

In 1924 the Office of Fisheries Research was closed down; it was reopened towards the end of 1927 by the appointment of Mr. R. S. Wimpenny as Director of Fisheries Research. In the report under review there is little of scientific work published, but it is evident that movements are on foot to establish a department sufficient to attack a few, at any rate, of the many problems of interest that Egyptian waters afford, not the least of which from a biological point of view would be a thorough survey of the conditions in the delta lakes themselves.

The Government has ordered a small motor Danish seiner to explore the possibilities of the fishing grounds on the Egyptian coasts, and a plea has been put forward for a marine laboratory and necessary scientific assistants, and also for a steam trawler for oceanographic research. It is to be hoped that this will soon materialise. The knowledge of the fundamental problems underlying the productivity of the sea is essential to fishery research, and, while to administrative officials the immediate gain may appear to be insignificant, it is certain that in the long run such work will prove its value. It is to be hoped, therefore, that the Egyptian Government will see its way clear to supply the means for the establishment of an active marine biological laboratory; situated as it would be amid surroundings of absorbing interest, with problems such as the interchange of faunas between the Red Sea and the Mediterranean and the effects of the Nile flood, it is certain that information would be forthcoming that would add much to our knowledge of life in the sea. F. S. R.

* Ministry of Finance: Coastguards and Fisheries Service. Report on the Fisheries of Egypt for the year 1928. By R. S. Wimpenny. (Cairo: Government Press, 1930.) P.T.5.

University and Educational Intelligence.

CAMBRIDGE.—Smith's prizes have been awarded as follows:—Mr. H. S. M. Coxeter (Trinity), Mr. H. R. Hulme (Gonville and Caius). Rayleigh prizes have been awarded as follows:—Mr. H. Davenport (Trinity), Mr. B. Kuttner (Christ's), Mr. J. C. P. Miller (Trinity).

LONDON.—The following doctorates have been awarded: *D.Sc. in Physics* to Mr. J. P. Andrews, East London College, for a thesis entitled "Investigation into the Elastic and Plastic Behaviour of Materials" (*Proc. Phys. Soc.*, 1925, 1931; *Phil. Mag.*, 1925, 1928–29, 1931). *D.Sc. in Geology* to Mr. E. Spencer for a thesis entitled "A Contribution to the Study of Moonstone from Ceylon and other Areas and of the Stability-Relations of the Alkali-Felspars", and a subsidiary contribution. *D.Sc. in Physics* on Mr. H. Shaw for a thesis entitled "Interpretation of Gravitational Anomalies", and fourteen subsidiary contributions.

APPLICATIONS for grants in aid of scientific investigations bearing on agriculture to be carried on in connexion with a university, university college, or other approved institution or society in England and Wales during the academic year beginning Oct. 1 next are invited by the Ministry of Agriculture and Fisheries. Conditions on which the grants will be made are to be found on Form A.53/T.G., copies of which are obtainable from the Secretary of the Ministry, 10 Whitehall Place, S.W.1. The latest date for the return of completed forms of entry is May 15.

SECONDARY education in England and America is the subject of an article by Dr. Grizzell, professor of secondary education in the University of Pennsylvania, appearing in the December number of *School Life*. This is the fortieth of a series of articles sponsored by the National Committee on Research in Secondary Education, and records some of the conclusions reached as the result of a carefully planned co-operative study undertaken by a joint committee of experts of the two countries in 1928. Dr. Grizzell recognises the existence in both of a tendency in the direction of wider educational opportunity for the adolescent; but the resultant general reorganisation has been more rapid in the United States. The recent development in England of the higher elementary and central schools is compared with the high school movement which began in the United States almost a century earlier. He notes also a tendency in both countries to extend the period of secondary education upward. The 'junior college' movement in America is the counterpart of the development in England of two-year courses of specialised study after the 'first' school examination, but is, to all intents and purposes, a separate institution and avoids extreme specialisation in the academic field. The greater part of the article is devoted to a survey of contrasting practices and divergent tendencies which the author has observed in every important aspect of secondary education in the two countries. Some of these differences are summed up in the dictum, "To the English teacher, education is dominantly an art; to the American it is rapidly becoming a science".

THE United States Commissioner of Education, discussing, in his report for 1928–29, recent significant events and tendencies in higher education, gives the first place to increased scientific investigation of institutional problems and objectives. Such investigations have been reported during the year by scores of universities. Scientific and semi-scientific methods of investigation have been ousting the older methods of philosophy and mere observance of tradition. William James's passion for grappling with 'stubborn facts' seems to pervade the learned world, and this is attributed to necessity rather than choice, for the increasing industrialisation, machine production, changing of social customs, and other characteristics of a fast evolving civilisation make imperative a correspondingly rapid adaptation on the part of educational institutions, and for this they find themselves compelled to depend more and more on research and scientific study. Changes in general organisation of collegiate work are illustrated by the rapid growth of 'junior colleges' (including the first two years of the traditional 4-years liberal arts college course): the increase in their number during the year amounted to 25 per cent. Registration of full-time students in colleges and universities meanwhile increased by only 2 per cent. With some of the pressure of numbers removed and with a continued increase in financial support, stress may now be put, says the Commissioner, on quality of output. Institutions are studying, as never before, both the quantitative and qualitative demands by society for their human product.

Birthdays and Research Centres.

Mar. 29, 1890.—Dr. H. SPENCER JONES, F.R.S., H.M. Astronomer at the Cape of Good Hope.

The erection of a large reflecting telescope in the southern hemisphere is an urgent need. It should have an aperture of at least 72 inches, since, for many purposes, great light gathering power is essential, and it should be equipped with a spectroscope adapted for one-, two-, or three-prism dispersion. Such a telescope would be available for determining the radial velocities of faint stars, and for the study of distant nebulæ and other problems which are beyond the reach of existing instrumental equipment. The full interpretation of many observations obtained with large instruments in the northern hemisphere is dependent upon similar observations being secured in the southern hemisphere.

In recent work, the need has been felt of a publication in which are summarised the analyses of spectra for which the multiplet relationships have been investigated. The identified energy levels in the atom and the excitation potentials and multiplet identifications of individual lines should be given. Many of the original papers are in publications which are not available for reference anywhere in South Africa.

April 4, 1852.—Prof. A. P. COLEMAN, F.R.S., emeritus professor of geology in the University of Toronto.

Recent work along the St. Lawrence and near Moose Factory and Churchill on Hudson Bay proves that the marine beds, long known in those regions, include not only postglacial deposits, as usually stated, but also interglacial beds. The interglacial sea reached twice the height of the postglacial one. The last glaciation in eastern America was much less massive than an earlier one, suggesting that the greater load of ice implied a correspondingly greater depression of the lowlands. How close to isostatic equilibrium do such adjustments come, and how much lag is to be expected when the load of ice is removed? Have similar relations been found between interglacial and postglacial marine levels in northern Europe?

Societies and Academies.

LONDON.

Physical Society, Feb. 6.—E. B. Moss: A ballistic recorder for small electric currents. The standard thread recorder is so modified that it records ballistic throws in instead of the usual steady deflection. By this means, the current-sensitivity may be increased at least twenty-five times.—F. J. Scrase: The instrumental phase-difference of seismograph records: an illustration of the properties of damped oscillatory systems. A discussion is given of the method of interpretation of the maxima shown on the records of earthquakes during the surface-wave phase. The usual procedure is to treat the waves (which actually appear as beats) as being truly simple harmonic. In general, this procedure does not necessarily lead to the correct interpretation. In direct registration, the true earth maximum may have occurred one half-period later than the time obtained by the usual correction. With galvanometric registration, the maximum may have occurred either one, two, or three half-periods earlier than the time indicated by the usual formula due to Galitzin. For direct registration, the phase correction at present in use appears to be as good as one of the alternatives. For galvanometric registration, the correction suggested by

Somville, which is one half-period less than Galitzin's, should be adopted.—**H. E. Beckett**: The reflecting powers of rough surfaces at solar wave-lengths. A hemispherical mirror was used for integrating diffusely-reflected energy upon a thermopile receiver. The paper deals at length with the errors inherent in the method and with the adjustment of the apparatus. The theory of the method is simplified by the introduction of an auxiliary specimen which, in particular, renders the observations independent of the degree of blackness of the thermopile receiver.

Institute of Metals (Annual General Meeting), Mar. 11.—**W. F. Collins**: The corrosion of early Chinese bronzes. The patina and patination deposits formed by corrosion have resulted in the formation of definite minerals. The Chinese bronzes contain an unusually high percentage of lead. This preliminary research indicates that the bronze metallurgy of the early Chinese is distinct from that of the Sumerians.—**C. F. Elam**: An investigation of the microstructures of fifteen silver Greek coins (500–300 B.C.) and some forgeries. All the genuine coins showed evidence of striking between dies, as opposed to the forgeries, which, with one exception, were made by casting only. Analyses indicated that the coins were sometimes made from nearly pure silver, and sometimes copper was added. The forgeries contained copper, and in two cases, zinc.—**H. J. Gough** and **H. L. Cox**: The mode of deformation of a single crystal of silver. A single crystal of silver has been tested under alternating torsional stresses with the especial object of studying the formation of twin bands. Throughout the tests, however, no definite twin markings were observed, although the surface of the specimen was covered by a complete system of slip-bands in good agreement with the maximum resolved shear stress law. The choice of silver as a suitable material for the study of the formation of twin bands under applied stress was made on the grounds that in the aggregate form silver is known to twin very readily. —**C. H. M. Jenkins**: Some properties of metallic cadmium. By maintaining cadmium cold during rolling, the material produced possesses properties markedly different from metal which is allowed to warm during this process. In the short-time tensile tests, worked material is stronger than cast material; but under prolonged stress the cast alloys are inferior to rolled samples. Microscopic examination was also undertaken on the various materials produced. The X-ray examination of samples of hot- and cold-worked cadmium does not indicate an allotropic modification at room temperature and ordinary pressures, but there are marked differences in properties, which suggest a preferred orientation.—**P. J. Durrant**: The constitution of the cadmium-rich alloys of the system cadmium-silver. The constitution of the alloys of cadmium and silver from 0 to 40 per cent by weight of silver has been re-investigated by the methods of thermal and micrographic analysis. The liquidus consists of four smooth curves which intersect with peritectic horizontals at 343°, 592°, and 640° C. In the solid state the system gives rise to the following solid solutions: (1) extending from 0 to 6 per cent by weight of silver; (2) extending from 18 to 33·5 per cent by weight of silver; (3) extending from 36·2 to 39 per cent by weight of silver.—**D. Stockdale**: The solid solutions of the copper-silver system. The mutual solubilities of copper and silver have been determined, chiefly by the method of examining quenched specimens under the microscope. As this method fails at low temperatures, further information about the position of the phase boundaries was sought by measuring the electrical resistance of quenched wires. A 'differential' method which shows up small, abrupt changes in the electrical resistance of alloys at the temperatures at which they occur is also described.—**T. P. Hoar** and **R. K. Rowntree**: A note on the silver-rich aluminium-silver alloys above 600° C. Aluminium of high purity and the combined use of thermal and micrographic analysis make possible certain modifications in the previously existing diagram.

PARIS.

Academy of Sciences, Feb. 9.—**Molliard**: The relations existing between the various organic acids elaborated by *Sterigmatocystis nigra*. In cultures containing insufficient mineral salts, both gluconic and citric acids are formed as oxidation products of the sugars. Both can serve as food material for the mould; but citric acid is not formed from gluconic acid.—**Paul Marchal**: Micropterism and seasonal dimorphism in *Trichogamma*.—**André Blondel**: The rationalisation of the electromagnetic equations.—**M. de Sparre**: Concerning Foucault's pendulum. Remarks on a communication of Charron.—Armand de Gramont was elected a free academician in succession to the late Achille Le Bel.—**A. Buhl**: Conoidal propagations in wave geometry. Waves derived from the ellipsoid.—**Jean Capoulade**: Green's harmonic function of a domain of revolution.—**Jean Pierre Robert**: Mediation and metaharmonic functions.—**Georges Calugaréano**: A generalisation of Borel's theorem on meromorph functions.—**L. Tchakaloff**: The interval of variability of ξ in the formula

$$\int_a^b p(x)\phi(x)dx = \phi(\xi)\int_a^b p(x)dx.$$

—**F. E. Myard**: The realisation of mechanisms with pure rolling.—**Paul Le Rolland**: A resonance method for measuring rigidity and testing the stability of a construction.—**E. Brylinski**: A new system of units. Discussion of a recent communication by A. Blondel on the same subject.—**Vernotte**: The impossibility of assuring at any moment a sufficient and known thermal isolation with a solid insulating material. The loss through the insulating material is only relatively small when the steady state is attained. At any given moment, the loss depends not only on the temperatures, but also on the variation of these temperatures with the time.—**L. Dubar**: Rectifying elements with copper oxide. By micrographic analysis, Pélabon has shown that the oxide layer of a copper oxide rectifier is essentially non-homogeneous and consists of a relatively thick and semi-conducting layer of cuprous oxide holding some cupric oxide in suspension, this layer being separated from the copper by a very thin semi-insulating skin of nearly pure cuprous oxide. The electrical properties of these layers have been studied separately, and the results are in agreement with Pélabon's hypothesis.—**Th. V. Jonescu** and **C. Mihul**: The dielectric constant and the conductivity of ionised gases.—**Jean Louis Destouches**: The capture of electrons by positive ions. Contrary to the views expressed by Rutherford, the results obtained show that the phenomenon of capture of electrons is the same whatever may be the relative velocity of the ions and electrons.—**J. Peltier**: The exploration of ferromagnetic bodies of revolution by the use of rotating fields.—**J. Gilles**: The dispersion of internal energy at the quadruple and triple terms $3sP$, $3pP$, $3pD$, in the spectra of the elements carbon, nitrogen, oxygen, and fluorine at different degrees of ionisation.—**Pauthenier** and **Bart**: The double refraction of safrol. Safrol, whether of commercial quality or carefully purified, shows no residual double refraction in either constant or alternating fields. This is not in agreement with the results of Leiser.—**Desmaroux** and **Mathieu**: Remarks on the structure

of nitrocellulose. Discussion of the results of X-ray studies of nitrocellulose.—**Mlle. O. Hun**: Contribution to the ebullioscopic study of the complexes formed by the cadmium halides and the corresponding alkaline halides.—**Augustin Boutaric** and **Jean Bouchard**: The influence of light on colloidal solutions in fluorescent media. The rôle of antioxygens.—**Maurice Auméras**: The specific heats of solutions of sodium sulphate.—**N. Slomnesco**: The decomposition of carborundum by a mixture of nitric and hydrofluoric acids.—**P. Cordier**: The dibenzylsuccinic acids.—**A. Mavrodin**: The action of ethylmagnesium halides on ethyl diethylcyanacetate.—**V. Hasenfratz**: Nativelle's digitaline and digitoxin.—**Jean Lacoste**: Stratigraphical notes on the southern Rif (Moulay Bou Chta region).—**Bogdan Varitchak**: Remarks on the distribution of the cytome at the moment of zoospore formation.—**L. Margaillan**: The oil of *Wrightia annamensis*, an oil resembling castor oil. This oil strongly resembles castor oil in physical and chemical properties; there is one point of difference, the *Wrightia* oil is much more soluble in light petroleum ether.—**J. Millot**: The comparative anatomy of the middle cephalo-thoracic intestine in the true spiders.—**A. B. Chauchard** and **S. Kajiwara**: The relation of the chronaxies of antagonists in narcosis produced by compression of the brain.—**Georges Bourguignon** and **Socrate Eliopoulos**: The action of iodine, calcium, and magnesium ions on the oscillometric index and the arterial pressure in trans-cerebral-dielectrolysis.—**R. Marcille**: An apparatus affording protection against toxic gases.—**Charles Richet**: Remarks on the preceding communication.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 16, No. 11, Nov. 15).—**William Hovgaard**: (1) The stress distribution in welds. By a process of integration and variation, which presupposes continuity, an expression, valid within the limit of elasticity, is obtained for the stress distribution in the case of a bar connected to another structural member subject to simple tension or compression.—(2) The stress distribution in welded overlapped joints.—**H. Diamond** and **F. W. Dunmore**: A radio system for blind landing of aircraft in fog (see NATURE, Feb. 14, p. 252).—**Theodore Theodorsen**: A sensitive induction balance for the purpose of detecting unexploded bombs. A power coil produces a field and the fluxes through two pick-up coils are compared. The field is considered to consist of the undisturbed power field and the superimposed field induced in the hidden object; the latter is detected by the pick-up system. A small 500-cycle generator is used.—**Frederick D. Rossini**: The heat of formation of water. The calorimeter was surrounded by a constant temperature jacket and contained a measured quantity of water, a temperature measuring device, stirring mechanism and a reaction vessel for burning the gases at constant pressure, and a heating coil. The thermal energy liberated by combustion of oxygen and hydrogen to form a measured mass of water is compared with that liberated by a measured quantity of electrical energy. Thus the results depend on the determination of a mass of water formed and a quantity of electrical energy passed. The heat of formation of one mole (18·0156 gm.) of liquid water found is $285{,}890 \pm 40$ absolute joules or $68{,}313 \pm 10$ gm. cal. (15°).—**Horace S. Isbell**: (1) Crystalline alpha and beta methyl-*d*-gulosides.—(2) The ring structure of mannose.—**M. Demerec** and **J. G. Farrow**: (1) Non-disjunction in the *X*-chromosome in *Drosophila virilis*.—(2) Relation between the X-ray dosage and the frequency of primary non-disjunctions of *X*-chromosomes in *Drosophila virilis*. Primary non-disjunction increases with X-ray dosage at first, but falls off eventually, when the fertility of treated flies also declines.—**L. J. Stadler**: Recovery following genetic deficiency in maize. Recovery of an 'inactive' gene has been observed equally in X-rayed and untreated material.—**Walter M. Nielsen**: Magnetic analysis of negative ions in mercury vapour. Electrons from a tungsten filament are projected parallel to a magnetic field of 100 gauss; mercury vapour passes up the discharge space and ions are produced by a beam of electrons. Positive or negative ions are 'pulled out' by an accelerating potential and analysed magnetically. Evidence was found of negative ions at pressures of the order of 10^{-4} mm. of mercury.—**Hugh L. Dryden** and **George C. Hill**: The pressure of the wind on large chimneys. An experimental chimney-stack, 10 ft. in diameter and 30 ft. high, was erected on the roof of one of the U.S. Bureau of Standards buildings and wind pressures measured at twenty-four stations round the circumference at a single elevation about two-thirds of the height from the base. Arrangements have been made for similar observations on a new chimney at the Bureau. Wind pressure on a chimney is a function of the ratio of height to diameter of chimney and possibly of surface-roughness. It may reach large values locally, but 20 lb. per square foot of projected area at a wind speed of 100 miles an hour is generally a safe value. Experiments on small cylinders cannot be used to predict wind pressure on account of the large scale effect.—**L. P. Eisenhart**: Projective normal co-ordinates.—**H. S. Vandiver**: (1) On the norm-residue symbol in the theory of cyclotomic fields.—(2) On the second factor of the class number of a cyclotomic field.—**E. T. Bell**: Periodic recurring series.—**H. F. Bohnenblust**: Note on singularities of power series.—**J. H. C. Whitehead**: A method of obtaining normal representations for a projective connexion.—**Tracey Yerkes Thomas**: On the unified field theory (1). Einstein's theory introduces the possibility of distant parallelism into the scheme of Riemannian geometry; in each point of the underlying continuum of space and time, there is a local Cartesian co-ordinate system in which the Pythagorican theorem is satisfied. These systems are determined by four independent vector fields. Subject to certain conditions, a system of sixteen wave equations is constructed to represent the combined gravitational and electromagnetic field.—**Marston Morse**: The critical points of a function of n variables.

Official Publications Received.

BRITISH.

Geological Survey Department: Tanganyika Territory. Short Paper No. 6: A Note on the Geology of the Country around Tendagaru, Lindi District. By Dr. John Parkinson. Pp. 16+7 plates. (Dar es Salaam.) 2*s.*

Canada. Department of Mines: Geological Survey. Memoir 163: Geology of Southern Alberta and Southwestern Saskatchewan. By M. Y. Williams and W. S. Dyer. (No. 2244.) Pp. iii+160+5 plates. Summary Report, 1928, Part C. (No. 2218.) Pp. 115. Summary Report, 1929, Part A. (No. 2251.) Pp. 319. Summary Report, 1929, Part C. (No. 2250.) Pp. 50. Economic Geology Series, No. 8: Zinc and Lead Deposits of Canada. By F. J. Alcock. (No. 2229.) Pp. vii+406+8 plates. 75 cents. (Ottawa: F. A. Acland.)

Department of Agriculture, Straits Settlements and Federated Malay States. Scientific Series, No. 4: The Bionomics and Control of *Leptocorisa acuta* Thunb., with Notes on other *Leptocorisa* spp. By G. H. Corbett. Pp. ii+40+7 plates. (Kuala Lumpur.) 1 dollar.

Southern Rhodesia. Geological Survey Bulletin No. 17: The Geology of the Country between Gatooma and Battlefields. By A. M. Macgregor. Pp. 144+13 plates. (Salisbury.) 4*s.* 9*d.*

Department of Health for Scotland. First Report of the Scottish Advisory Committee on Rivers Pollution Prevention. 1: Summary of the Law relating to Rivers Pollution Prevention; 2: The River Tweed and its Tributaries. Pp. 58. (Edinburgh and London: H.M. Stationery Office.) 1*s.* net.

Proceedings of the Society for Psychical Research. Part 117, Vol. 39, February. Pp. 347-373. (London.) 2*s.* 6*d.*

South Australia. Annual Report of the Director of Mines and Government Geologist for 1929. Pp. 8. (Adelaide: Harrison Weir.)

British Science Guild. A Report on the Scientific and Professional Staffs in the Public Services and Industry. Prepared by the Committee on the Position of the Technical Expert in the Public Services and Industry. Pp. vi+62. (London.) 1s.

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 69, No. 410, February. Pp. 213-324+xxx. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

Department of Health for Scotland. Milk Consumption and the Growth of School Children. Report of an Investigation in Lanarkshire Schools. By Dr. Gerald Leighton and Dr. Peter L. McKinlay. Pp. 20. (Edinburgh and London: H.M. Stationery Office.) 3d. net.

London, 1930. IX International Horticultural Congress by the Invitation of the Royal Horticultural Society and under the Auspices of the International Committee for Horticultural Congresses, August 7th to 15th. Report and Proceedings. Pp. 450. (London.) 15s.

Proceedings of the Linnean Society of London. 142nd Session, from November 1929 to May 1930. Pp. iv+252. 10s. Session 1930-31. Part 1. Pp. 16. 6d. (London.)

The Transmutation of the Chemist. (The Second S. M. Gluckstein Memorial Lecture, 1930.) By Dr. A. E. Dunstan. Pp. 22. (London: The Institute of Chemistry.)

Proceedings of the Edinburgh Mathematical Society. Series 2, Vol. 2, Part 3, January. Edited by Prof. H. W. Turnbull and Dr. E. T. Copson. Pp. 129-180. (London: G. Bell and Sons, Ltd.)

Journal of the Royal Statistical Society. Vol. 94, Part 1. Pp. 172+xiii. (London.) 7s. 6d.

Seale-Hayne Agricultural College, Newton Abbot, Devon. Pamphlet No. 35: Clotted Cream. By W. B. V. Tresidder. Pp. 16. (Newton Abbot.)

Records of the Albany Museum. Vol. 4, Part 1, January 9th. Pp. 168+17 plates. (Grahamstown.) 12s. 6d.

British Scientific Instruments in Industry. Pp. 48. (London: British Optical Instrument Manufacturers' Association, Ltd.)

Department of Scientific and Industrial Research. Building Science Abstracts. Vol. 4 (New Series), No. 1, January. Abstracts Nos. 1-214. Pp. iii+38. (London: H.M. Stationery Office.) 9d. net.

Department of Scientific and Industrial Research. The Investigation of Atmospheric Pollution: Report on Observations in the Year ended 31st March 1930. Sixteenth Report. Pp. vii+74. (London: H.M. Stationery Office.) 4s. net.

City and County of Bristol: Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September 1930. Pp. 28+5 plates. (Bristol.) 2d.

Transactions and Proceedings of the New Zealand Institute. Vol. 61, Parts 3-4, November, 1930. Pp. iii+441-566+plates 68-91. (Wellington.)

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1341 (Ae. 473—T. 2971): The Motions, at the Stall, of a Bristol Fighter Aeroplane with Slot and Aileron Control on both Planes. By K. W. Clark. Pp. 7+6 plates. 9d. net. No. 1352 (Ae. 483—T. 2983): Movement of Smoke in the Boundary Layer of an Aerofoil without and with Slot. By T. Tanner. Pp. 2+8 plates. 1s. net. No. 1343 (Ae. 475—T. 2995): The Automatic Timing of Aircraft over a Speed Course. By J. K. Hardy and K. V. Wright; with an Appendix by S. B. Gates. Pp. 9+9 plates. 1s. net. No. 1354 (Ae. 485—T. 2810): Lift and Drag of Blackburn "Iris". By L. P. Coombes and R. K. Cushing. Pp. 5+4 plates. 6d. net. (London: H.M. Stationery Office.)

University of London: University College. Report of the University College Committee (February 1930–February 1931) with Financial Statements (for the Session 1929–30), and other Documents, for Presentation to the Court and the Senate. Pp. 136. (London: Taylor and Francis.)

Empire Cotton Growing Corporation. Reports received from Experiment Stations, 1929–1930. Pp. xi+342. (London.) 2s. 6d.

Proceedings of the Royal Society. Series A, Vol. 130, No. A814, February 3. Pp. 431-551. 6s. Series B, Vol. 107, No. B753, February 3. Pp. 417-510. 6s. (London: Harrison and Sons, Ltd.)

The South-Eastern Naturalist and Antiquary: being the Thirty-fifth Volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Thirty-fifth Annual Congress, held at Portsmouth, 1930. Edited by A. F. Ravenshear. Pp. lxv+131. (London.) 5s. net.

Memoirs of the Geological Survey of India. Vol. 58: The Gondwana System and related Formations. (Coal in India, 2.) By Dr. Cyril S. Fox. Pp. v+241+10 plates. (Calcutta: Government of India Central Publication Branch.) 6 rupees; 9s. 9d.

Department of Scientific and Industrial Research. Report for the Year 1929–30. (Cmd. 3789.) Pp. 224. (London: H.M. Stationery Office.) 3s. 6d. net.

Journal of the Indian Institute of Science. Vol. 13A, Part 13: Amylase from Wheat. By Dattatreya Vishnu Karmarkar and Vinayak Narayan Patwardhan. Pp. 159-164. 12 annas. Vol. 13A, Part 14: Biological Oxidation of Sulphur. Part 4: Influence on Ammonification and Nitrification in Activated Sludge. By C. V. Ramaswami Ayyar. Pp. 165-171. 1 rupee. (Bangalore.)

Indian Journal of Physics, Vol. 5, Part 7, and Proceedings of the Indian Association for the Cultivation of Science, Vol. 14, Part 7. Conducted by Sir C. V. Raman. Pp. 669-767+ix. (Calcutta.) 1.8 rupees; 2s.

Journal of the Chemical Society. February. Pp. iv+221-444+vi. Supplementary Number, containing Title-Pages, Contents and Indexes, 1930. Pp. 2793-2900+4+xxxii. (London.)

Economic Advisory Council. Committee on the Mineral Content of Natural Pastures. Sixth Report. Pp. 66. (London: H.M. Stationery Office.) 1s. net.

FOREIGN.

Album of Abyssinian Birds and Mammals. From Paintings by Louis Agassiz Fuertes. (Special Publication of Field Museum of Natural History.) Pp. iv+32 plates. (Chicago: Field Museum of Natural History.) 3 dollars.

Abridged Scientific Publications from the Kodak Research Laboratories. Vol. 13, 1929. Pp. 271+vii. (Rochester, N.Y.: Eastman Kodak Co.)

Journal of the Federated Malay States Museums. Vol. 16, Parts 1 and 2, December. Pp. 174. (Kuala Lumpur.)

Field Museum of Natural History. Anthropology Memoirs, Vol. 2, No. 2: Archaeological Explorations in Peru. Part 2: The Northern Coast. By Prof. A. L. Kroeber. (First Marshall Field Archaeological Expedition to Peru.) Pp. 45-116+plates 14-31. Botanical Series, Vol. 8, No. 3: Studies of American Plants, IV. By Paul C. Standley. (Publication 281.) Pp. 131-236. Zoological Series, Vol. 17, No. 7: Birds of the Marshall Field Peruvian Expedition, 1922–1923. By John T. Zimmer. (Publication 282.) Pp. 231-480. (Chicago.)

Société des Nations: Institut International de Coopération Intellectuelle (League of Nations: International Institute of Intellectual Cooperation). Code International d'Abbréviations des Titres de Périodiques. Élaboré par un sous-Comité sous les auspices de l'Institut International de Coopération Intellectuelle. (International Code of Abbreviations for Titles of Periodicals. Drawn up by a sub-Committee under the auspices of the International Institute of Intellectual Cooperation.) Pp. 12. (Paris.) 2·50 francs.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 98: A Summary of Rice Breeding Work, 1921–29. By G. P. Morris and Mohammad Eff. el Dib. Pp. 15+7 plates. 5 P.T. Bulletin No. 102: A Concise Account of Barley Breeding, 1921–1929. By G. P. Morris and M. A. Kosheiry Eff. Pp. 19+4 plates. 5 P.T. (Cairo: Government Press.)

Acta Phytochimica. Edited by Prof. Keita Shibata. Vol. 5, No. 2, December. Pp. 99-211. (Tokyo: The Iwata Institute of Plant Biochemistry.) 2.00 yen.

Ministry of Public Works, Egypt: Physical Department. Meteorological Report for the Year 1924. Pp. xiii+174. (Cairo: Government Press.) 40 P.T.

Sudan Notes and Records. Vol. 13, 1930, Part 2. Pp. iv+149-294+20 plates. (Khartoum.) 30 P.T.; 6s.

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft. 111 Jahresversammlung vom 11 bis 14 September 1930 in St. Gallen. Pp. 500+60+8 Tafeln. (Aarau: H. R. Sauerländer und Co.)

Anuario del Observatorio Astronómico de Madrid para 1931. Pp. 476. (Madrid: Instituto Geográfico y Catastral.)

Pubblicazioni della R. Università degli Studi di Firenze. Fascicolo N. 47: Osservazioni e Memorie del R. Osservatorio Astrofisico di Arcetri. Pp. 56. (Firenze.)

Scientific Publications of the Cleveland Museum of Natural History. Vol. 1, No. 4: Notes on a Collection of Birds from Arizona and New Mexico. By Harry C. Oberholser. Pp. 83-124+plate 18. (Cleveland, Ohio.)

Scientific Papers of the Institute of Physical and Chemical Research. Nos. 278-281: On the Hydrosol of Silicic Acid, 1: Hydrosol made from Ethyl Silicate by Hydrolysis, by Kenkyo Inaba; On the Hydrosol of Silicic Acid, 2: On the Electrical Properties of the Hydrosol of Silicic Acid, by Kenkyo Inaba; On the Relation of Vitamins to Carcinogenesis, by Waro Nakahara; Some Remarks on the Angular Intensity Distribution of Continuous X-Ray Spectrum, III, by Yoshikatsu Sugiura. Pp. 39. 65 sen. No. 282: Spectrum of Singly Ionized Chlorine (Cl II). By Kiyoshi Murakawa. Pp. 41-67. 40 sen. Supplement No. 12: Effect of adding Colloids to the Electrolytic Solutions for preparing the Anodic Film on Aluminium. By Shoji Setoh and Akira Miyata. Pp. 6. 10 sen. (Tōkyō: Iwanami Shoten.)

U.S. Department of Agriculture. Farmers' Bulletin No. 1638: Rat Proofing Buildings and Premises. By James Silver, W. E. Crouch and M. C. Betts. Pp. ii+26. 5 cents. Technical Bulletin No. 206: Ecological Studies of the Beet Leaf Hopper. By Walter Carter. Pp. 115+8 plates. 30 cents. (Washington, D.C.: Government Printing Office.)

Bulletin, Technical Series, Vol. 11, No. 3: Laboratory Concentration of the Missouri Iron Ores of Iron Mountain and Pilot Knob. By F. D. DeVaney and S. R. B. Cooke. Pp. 38. (Rolla, Mo.: School of Mines and Metallurgy.)

Smithsonian Miscellaneous Collections. Vol. 73, No. 7: Opinions rendered by the International Commission on Zoological Nomenclature. Opinions 115 to 123. (Publication 3072.) Pp. 36. (Washington, D.C.: Smithsonian Institution.)

Annual Report of the Naval Observatory for the Fiscal Year 1930. Pp. 22. (Washington, D.C.: Government Printing Office.)

Cornell University Agricultural Experiment Station. Bulletin 510: Growing Onions on the Muck Soils of New York. By J. E. Knott. Pp. 34. Bulletin 511: The Collection of Taxes by the State of New York, and the Division of these Revenues with Units of Local Government. By M. Slade Kendrick. Pp. 53. Bulletin 512: The Money Income of Farm Boys in a Southern New York Dairy Region. By Howard Wayland Beers. Pp. 55. Memoir 133: The Effect of Spiral Ringing on Solute Translocation and the Structure of the Regenerated Tissues of the Apple. By L. H. Macdaniels and Otis F. Curtis. Pp. 31+5 plates. (Ithaca, N.Y.)

Carnegie Institution of Washington. Year Book No. 29, July 1, 1929, to June 30, 1930; with Administrative Reports through December 12, 1930. Pp. xix+454. (Washington, D.C.: Carnegie Institution.)

Proceedings of the American Academy of Arts and Sciences. Vol. 66, No. 1: A Report on the Coastal Waters of Labrador, based on Explorations of the *Chance* during the Summer of 1926. By C. Iselin. Pp. 57. 75 cents. Vol. 66, No. 2: The New World Species of the Genus Solenopsis (Hymenop. Formicidae). By William S. Creighton. Pp. 39-151+8 plates. 2 dollars. Vol. 66, No. 3: Equations for Vapor Pressures and Latent Heats, including Approximate Equations for Solid Compounds containing a Gaseous Component. By Louis J. Gillespie. Pp. 153-165. 45 cents. Vol. 66, No. 4: An Experimental Study of the Absolute Temperature Scale. 1: The Construction of several Types of Platinum Resistance Thermometers. By James A. Beattie, David D. Jacobus and John M. Gaines, Jr. Pp. 167-184. 45 cents. (Boston, Mass.)

Bulletin of the Earthquake Research Institute, Tokyo Imperial University. Vol. 8, Part 4, December. Pp. 377-458. (Tōkyō: Iwanami Shoten.) 95 sen.

Records of Oceanographic Works in Japan. Vol. 2, No. 2, December 1930. Pp. 57-110+plates 6-10. Vol. 3, No. 1, December 1930. Pp. 34. Tokyo: National Research Council of Japan.)

Japanese Journal of Mathematics. Transactions and Abstracts, Vol. 7, No. 3. Pp. 199-266. (Tokyo: National Research Council of Japan.)

U.S. Department of Commerce: Bureau of Standards. Miscellaneous Publication No. 117: Units used to Express the Wave Lengths of Electromagnetic Waves. By Henry D. Hubbard. Pp. 4. 5 cents. Research Paper No. 252: Precision of Color Temperature Measurements under various Observing Conditions; A New Color Comparator for Incandescent Lamps. By Deane B. Judd. Pp. 1161-1177. 10 cents. Research Paper No. 258: The Freezing Point of Nickel as a Fixed Point on the International Temperature Scale. By H. T. Wensel and W. F. Roeser. Pp. 1309-1318. 5 cents. (Washington, D.C.: Government Printing Office.)

CATALOGUES.

Sanusin 'Sempules' and Sanusin Pessaries. Pp. 4. Radio-Malt. Pp. 4. (London: The British Drug Houses, Ltd.)

Periodica: the Cannon House Catalogue of Journals of all the Sciences. (N.S. No. 4.) Pp. 74. (London: Wm. Dawson and Sons, Ltd.)

Catalogue of Books on Chemistry and Chemical Technology. Pp. 52. (London: H. K. Lewis and Co., Ltd.)

The Nickel Bulletin. Vol. 4, No. 3, March. Pp. 65-92. (London: The Mond Nickel Co., Ltd.)

Diary of Societies.

FRIDAY, MARCH 27.

ROYAL SOCIETY FOR THE PROTECTION OF BIRDS (at Middlesex Guildhall, Westminster), at 3.—Annual Meeting.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section), at 5.

INSTITUTION OF ELECTRICAL ENGINEERS (West Wales (Swansea) Sub-Centre) (at Electricity Offices, Swansea), at 6.

INSTITUTION OF STRUCTURAL ENGINEERS (at Chamber of Commerce, Birmingham), at 6.30.—Annual General Meeting.

INSTITUTE OF FUEL (East Midlands Section) (at Technical College, Derby), at 7.—P. H. N. Ulander: The Power Consumption of Boiler-house Auxiliaries.

MANCHESTER ASSOCIATION OF ENGINEERS (Annual General Meeting) (at Engineers' Club, Manchester), at 7.—C. Longden: Developments in Modern Foundry Practice.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Exhibition of Industrial Kinematograph Films.

JUNIOR INSTITUTION OF ENGINEERS (at County Hotel, Newcastle-on-Tyne), at 7.15.—L. Clegg: Synthetic Resin Products.

INSTITUTE OF BRITISH FOUNDRYMEN (Birmingham, Coventry, and West Midlands Branch) (at Chamber of Commerce, Birmingham), at 7.30.—T. G. Bamford: The Melting of Cast Iron.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—C. E. Prince: Light Sensitive Work in Modern Industry.

GEOLOGISTS' ASSOCIATION (in Architectural Theatre, University College), at 7.30.—Prof. L. S. Palmer: On the Pleistocene Succession of the Bristol District.—E. M. Venables: Notes on the Geology of Felpham, near Bognor Regis.

MICROSCOPICAL SOCIETY OF WALES (at Cardiff Technical College), at 7.30.—Dr. P. Morgan: The Microscope in Bacteriological Work.

INSTITUTION OF STRUCTURAL ENGINEERS (at Merchant Venturers' Technical College, Bristol), at 7.30.—W. E. Francis: Testing of Materials.

JUNIOR INSTITUTION OF ENGINEERS (at Metallurgical Club, Sheffield), at 7.30.—J. F. Webster: Notes on Recent Road Transport Legislation.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. A. F. MacCallan: Trachoma: its Importance as a World-wide Disease.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Lord Rutherford: Helium and its Properties.

SATURDAY, MARCH 28.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Lord Rutherford: Recent Researches on the Alpha Rays (4).

INSTITUTE OF BRITISH FOUNDRYMEN (East Midlands Branch) (at Loughborough College), at 6.—Dr. A. B. Everest: Recent Developments in Special Cast Iron.

INSTITUTE OF BRITISH FOUNDRYMEN (Newcastle-on-Tyne and District Branch) (at Neville Hall, Newcastle-on-Tyne), at 6.15.—The Brackelsberg Process for Production of Grey Cast Iron.

MONDAY, MARCH 30.

INSTITUTE OF ACTUARIES, at 5.—J. B. Maclean: Notes on the Practical Application of the Contribution Method of Distributing Surplus.—W. Pollock: Variations under Altered Conditions in the Bonus Provided by a Given Scale of Premiums.

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

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—H. Astbury and others: Discussion on The Rupturing Capacity of E.H.T. and L.T. Switchgear to be installed on Consumers' Premises.

INSTITUTION OF LOCOMOTIVE ENGINEERS (at Chamber of Commerce, Birmingham), at 7.—H. Chambers: Improvements in Water Pick-up Gear for Locomotives.

HUNTERIAN SOCIETY OF LONDON, at 7.15.—Dr. E. P. Poulton and Dr. O. Heath: Discussion on The Common Cold.

TUESDAY, MARCH 31.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 6.15.—Annual General Meeting and Induction of New President, J. Kewley.

ROYAL AERONAUTICAL SOCIETY (jointly with Institution of Automobile Engineers) (at Royal Society of Arts), at 6.30.—High-Speed Heavy-Oil Engines.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group) (Annual General Meeting), at 7.—S. O. Rawling: Examination of the Newman Exposure Apparatus.—A. S. Newman: A New Design of Microscope.

SHEFFIELD METALLURGICAL ASSOCIATION (at Sheffield), at 7.30.—Dr. E. W. Fell: Gases in Steel (with special reference to Oxygen).

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (jointly with Diesel Engine Users' Association, Institute of Fuel, Institute of Marine Engineers, Institution of Automobile Engineers, Institution of Engineers-in-Charge, Institution of Mechanical Engineers, Institution of Petroleum Technologists, Junior Institution of Engineers, Royal Aeronautical Society, and Society of Engineers) (at Institution of Mechanical Engineers), at 7.45.—Dr. S. J. Davies and E. Giffen: Injection, Ignition, and Combustion in High-Speed Heavy-Oil Engines.

WEDNESDAY, APRIL 1.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—R. Naismith: (*a*) Short Distance Observations on Long-Wave Phenomena; (*b*) Field Strength Measurements on Daventry 5XX.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—Debate.

SOCIETY OF GLASS TECHNOLOGY (London Section) (at National Physical Laboratory, Teddington), at 7.30.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—R. C. Frederick: Carbon Monoxide Poisoning: Its Detection and the Determination of the Percentage Saturation in Blood, by means of the Hartridge Reversion Spectroscope.—H. M. Mason and G. Walsh: Experiments on the Hardness of Fats.—Dr. B. S. Evans: A New Process for the Determination of Small Amounts of Bromide in Chloride.—S. G. Walton and R. G. O'Brien: The Use of Bromine as a Reagent in the Determination of Alkaloids.

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

PUBLIC LECTURE.

SATURDAY, MARCH 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Prof. J. R. Ainsworth Davies: Fur-bearing Animals in Canada.

CONFERENCE.

SATURDAY AND MONDAY, MARCH 28 AND 30.

SOCIETY FOR EXPERIMENTAL BIOLOGY (at Edinburgh).

Saturday, March 28 (in Department of Zoology).

10 A.M. to 1 P.M.—J. Hammond: The Life of the Unfertilised Ovum.

A. J. M. Smith: The Problem of the Vitelline Membrane: (*a*) Gas Exchange and Osmotic Equilibria of the Infertile Hen's Egg.

J. Needham, M. Stephenson, and D. M. Needham: The Problem of the Vitelline Membrane: (*b*) Lactic Acid Production in the Infertile Hen's Egg.

J. Needham: The Problem of the Vitelline Membrane: (*c*) The Osmotic Properties of the Isolated Membrane.

H. O. Bull: Conditioned Responses and Salmon Smolts.

W. H. Pearsall and M. Pilling: The Physiology of Storage in the Apple.

E. C. Barton Wright: The First Sugar of Photosynthesis.

(In Department of Animal Genetics.)

2.15 to 3.45.—F. A. E. Crew and L. Mirskaia: (*a*) Genetic and Physiological Studies on the Hairless Mouse; (*b*) Observations on the Aged Male and Female Mouse.

B. P. Wiesner, P. G. Marshall, J. M. Robson, H. Taylor, and R. E. Illingworth: Recent Experiments on the Dynamics of the Sex Cycle.

3.45 to 5.30.—Demonstrations.

5.30 to 6.30.—E. Boyd: Experiments on Skin Transplantation in the Mouse.

E. M. Gilroy: The Effect of Arginine and Thyroxine on the Growth Rate of a Transplantable Tumour of the Mouse.

Monday, March 30 (in Department of Bacteriology).

10 A.M. to 12.15 P.M.—I. J. Blake: Experimental Infection of *Salmo fario* by *Bacillus salmonicida*.

A. Cunningham and T. Gibson: Recent Work on the Filterable Gonidial Stages of Bacteria.

T. J. Mackie, M. H. Finkelstein, and H. J. Gibson: The Natural Antibodies of Various Animal Species.

J. M. Alston: Analysis of Antigens on the Basis of Chemistry and Function.

M. H. Christison: Microbic Dissociation with Special Reference to the Tubercle Bacillus.

12.15 to 1.—Demonstrations.

(In Department of Zoology.)

2.15 to 3.45.—A. Walton: Gas Storage of Mammalian Spermatozoa.

A. L. Craig Bennett: Observations on the Influence of Temperature on the Breeding of Animals.

A. Graham: Temperature and *p*H Optima of Invertebrate Enzymes.

3.45 to 4.30.—Demonstrations:

4.30 to 6.—J. W. Gregor: Experimental Methods in Taxonomy.

V. E. McM. Davey: Inheritance of Colour in Certain Species of *Brassica*.

W. Black: Inheritance of Colour in the Potato Tuber.

ANNUAL MEETING.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts).

Friday, March 27, at 10.30 A.M.—Dr. H. H. Blache: The Present Position of the Diesel Engine for Marine Purposes.

H. E. Yarrow: Water Tube Boilers in Some Recent Merchant Ships with Service Results.

W. H. Howden: Some Modern Examples of Air Heaters.

At 2.30.—E. F. Spanner: Beam-Frame Connexions.