NATURE

THURSDAY, MARCH 17, 1921.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters should be addressed to the Publishers.

Editorial communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.

University Grants and Needs.

THE Report of the University Grants Committee (Cmd. 1163, *3d.* net), dated February 3, confirms the opinion expressed in these columns on several occasions that greater financial assistance must be given to the Universities. It makes it clear that the present resources of the Universities are quite inadequate to meet the demands made upon them. Their expenditure has grown enormously, and even if the pre-war incomes had been doubled, it is doubtful whether they would be relatively as well off as they were before the war. Added to this there is an unprecedented influx of students; the number of full-time students in University institutions in Great Britain in receipt of annual grants in 1919–20 was 37,748 (including 11,682 ex-Service students), as compared with 23,872 in 1913–14. Here is ample evidence of the necessity for a much greater income. Unfortunately, there is not the same evidence that the necessity is being met. On the contrary, the Report clearly indicates that the Universities are unable to meet their existing responsibilities, still less to contemplate justifiable and desirable developments. Especially is this the case in respect of the emoluments of the teachers, which are still, we are told, "below the minimum necessitated by the present economic conditions." The Committee is of opinion that unless further substantial improvement is made in the salaries of the teaching staffs, the efficiency of University education will be seriously endangered.

With this view anyone conversant with University life will cordially agree, as also with the statement that the emoluments should correspond to those now enjoyed by other professional classes, and show a reasonable ratio to the salaries paid in other branches of the teaching profession itself. So far, so good. But at this point the Report shows a lack of precision and logic, especially with reference to the scheme of remuneration put forward by the Association of University Teachers. In one place it seems to advocate basic minimum salaries, within grades and faculties, below which no teacher should be appointed; in another it doubts whether the principle of universal flat rates and automatic increments is either possible or desirable. It would be interesting to know how the Universities are to agree upon basic minimum salaries without accepting the principle of universal flat rates. There is one way, and that is to have different basic minimum salaries in different institutions—in other words, to grade the institutions; but it is questionable whether anyone, other than a doctrinaire, would seriously advocate a policy of this kind. In this connection it may be remarked that at a recent conference of representatives of the governing bodies of Universities with the council of the Association of University Teachers, a joint committee, comprising an equal number of representatives from both sides, was appointed to consider the whole question of remuneration of University teachers, and its report will be awaited with interest.

With regard to automatic increments, one wonders whether the Committee has heard of the Burnham scales of salaries or of the system of remuneration in operation in the Civil Service. The Report seems to indicate that promotion and its corollary—increase of remuneration—must come from the interchange of teachers between the various institutions. A little reflection will show the absurdity of such a suggestion. Of the important problem how to attract the best brain power to the staffs of the Universities in view of the financial inducements held out by the secondary schools, backed up by the Burnham scales of salaries, the Report has little to offer by way of a solution. One feels that the Committee would have been well advised to have left detailed criticisms on salaries to the University authorities. Committees are apt to become dogmatic.

In connection with the matter of superannuation, the Report emphasises three principles from which few will dissent—the preservation of the autonomy of the Universities, the free interchange of teachers among educational institutions, and a wide choice of benefits for the beneficiaries; but it carefully omits to state, let alone to emphasise, another important principle, viz. that University teachers should have superannuation benefits at least equivalent to those given by the State to other teachers. Why the autonomy of the University should be emphasised in connection with the question of superannuation is a mystery to the plain man. No one suggests that an annual grant from the Treasury of 1,500,000*l*. is going to limit the autonomy of the Universities; but when University teachers ask that the School Teachers (Superannuation) Act should be extended to the Universities at an estimated additional cost of no more than 70,000*l*. or 80,000*l*. per annum, the bogey of loss of autonomy is immediately raised, and one wonders why. Again, it is one thing to enunciate principles; it is another to carry them into practice. It is all very well for the Committee to talk of the free interchange of teachers and to express a pious hope that it will materialise; but the fact is, there exists at the present moment a distinct barrier in the Superannuation Act to the free interchange of teachers, and there is no guarantee that this barrier will be removed. Further, while the sympathetic attitude of the Chancellor of the Exchequer to the senior members of the staffs who are precluded from profiting by the full benefits of the federated superannuation system is commendable, it is important to note that the capital sum necessary to meet these grievances would amount to something like one and a half millions. Unless we are greatly mistaken, Mr. Chamberlain has no intention of asking the Government for any such amount. The sum of half a million has been suggested, which means that only about a third of retrospective benefits will accrue to those in the federated system. Under the Teachers Act full benefits would accrue. Such distinctions as these do not conduce to harmony, and University teachers cannot be expected to remain content under them.

One or two other points may be noticed. The observations on the tenure and status of teachers, on equipment and accommodation, and particularly those on libraries and special national needs, are interesting and informative, but the suggestion that the three University colleges—Reading, Nottingham, and Southampton—should each look out for a patron University under the ægis of which they might continue their present activities is not alluring. We dislike the principle of a patron University appointing representatives to approve courses and curricula and nominating external examiners. It smacks too much of educational bureaucracy. Why should not these three colleges together constitute a new University and work out their own destinies? In course of time, when the financial position became easier, no doubt they would hive off from one another as full-fledged Universities.

In a paragraph on finance the Report gives some important facts and figures. In his letter of July 16, 1920, Mr. Chamberlain states that, subject to the overriding necessities of national finance, he will submit to Parliament an increase in the vote from one million to one and a half millions in the estimate for 1921–22. While this will make an appreciable difference, it will not meet the needs of the present; other sources will have to be drawn upon. It would be unwise to expect much from a greater increase of fees—already the fees are two or three times greater than they are in America. Apparently little can be expected from private benefactions. There remains, therefore, the local authorities. The principle of a uniform 1*d*. rate throughout the country for University education is sound, but the allocation of the various areas to their respective Universities would be difficult. All the same, looking to the future, the Government might reasonably ask the University Grants Committee to prepare a scheme of areas for the purpose of a possible rate of this kind. If such a scheme of rate aid were adopted, it would naturally form a new basis for estimating the Treasury contribution in the future.

Meteorological Physics.

Physics of the Air. By Prof. W. J. Humphreys. Pp. xi+665. (Philadelphia: J. B. Lippincott Co., 1920.) 5 dollars.

STUDENTS of the science of the atmosphere have read with interest and appreciation the articles by Prof. W. J. Humphreys, of the Weather Bureau of the United States, on various aspects of the physics of the atmosphere which appeared from time to time in the Journal of the Franklin Institute of Philadelphia during the years 1917–20. The reproduction of these articles, revised and collected into a book for publication by the institute, is a notable and welcome event in the history of the study of the air.

Prof. Humphreys is known to us all as an accomplished physicist who is not averse from mathematical reasoning, with a wide range of knowledge; a cautious and rigorous thinker, a competent critic, a clear writer, and a shrewd observer who is well acquainted with the inherent difficulty of associating the unconditioned or uncontrolled phenomena of the atmosphere with the carefully conditioned and completely controlled experiments of the physical laboratory. He is, perhaps, best known to us as having been the first to offer an explanation on a deductive basis of the separation of the atmosphere into troposphere and stratosphere, which appeared almost at the same time as Col. Gold's memoir in the Proceedings of the Royal Society, and as having constructed a very useful diagram of the chemical composition of the atmosphere at different heights, also arrived at deductively, which is reproduced in Prof. Willis Moore's "Descriptive Meteorology" and in the work now under review. It is none the less interesting because Dr. Chapman and Mr. Milne have suggested to the Royal Meteorological Society that the hydrogen which occupies so large a part of the diagram should be left out.

The results of the assiduous study of the phenomena of the atmosphere from the point of view which is characterised by the two examples just given cannot fail to be of interest and importance for meteorology and meteorologists. They range over an extraordinarily wide field. The mechanics and thermodynamics of the atmosphere, including the average meteorological conditions of the surface and the upper air, the physical aspects of their changes, the composition of the atmosphere, insolation and radiation, atmospheric circulation, evaporation and condensation, rain and raindrops, fogs, clouds, thunderstorms and lightning, form only the first part. It includes a very good chapter on winds adverse to aviation. The second part is devoted to atmospheric electricity and auroras, and the third to atmospheric optics, a very acceptable section in view of our lack of a summary of the subject in English books. The fourth deals with factors of climatic control, and comprises a penetrating discussion of the principal theories of glacial epochs, with a remarkably novel and effective discussion of the possible or probable effects of vulcanism.

The book is fully illustrated with many excellent diagrams and photographs excellently reproduced. The pictures of the succession of recorded volcanic eruptions are quite fascinating. Prof. Humphreys may be congratulated on having received from the Franklin Institute such effective assistance in that important side of the presentation of a subject which is largely dependent upon the success of its illustrations.

Apart from the general excellence of the book and the presentation of its material, the parts which impress one most on reading them for the first time are the chapters on thunderstorms and lightning, atmospheric electricity and auroras, and atmospheric optics, as examples of close physical reasoning, and the chapters on factors of climatic control as an example of reasoning of a more general character.

Where there is such a wealth of subject details can scarcely be regarded, but one or two points attract attention. There is nothing in the index under the letter "U," and the reader is left to draw his own conclusions about the units of the physics of the air, which, in the author's country as in ours, involve a question of real importance to progress in science. It must be remembered that the study of the atmosphere appeals not only to students in physical laboratories where intricate questions about units are all in the day's work, but also to persons outside who care little or nothing for the co-ordination of the various parts of the subject, and to whom any references in unfamiliar units are an unmitigated bore. Such questions should, therefore, be treated in a manner that leaves no room for uncertainty. On p. 30, in a discussion of temperature changes under variations of pressure, Prof. Humphreys tosses $g=981$ into a mixture of p's and T's with scarcely any warning to his readers, but on p. 33 he makes use of Db as the equivalent of pressure p where D is the density of mercury and b the barometric height in millimetres! The explanation of that cryptic equation affords quite a good exercise for the student of physics, but it is not the same as $g=981$. It is not quite fair to his readers to subject their intelligence to this kind of gymnastic, and when physical reasoning has to be addressed to unprofessional, as well as to professional, physicists there is really no alternative but to have a coherent and consistent system of units and to stick to it. The longer the step is postponed, the worse for us. One offence against the life-long habits of a reader may be condoned if it is sufficiently pressed, but no one can expect pardon for two such within three pages of the same book.

On p. 43 the author expresses his preference for "isothermal region" as against "stratosphere" as a name for that part of the atmosphere of which the characteristic feature is that there is no change of temperature with height. This is really astonishing, because to regard the "isothermal region" as really isothermal would be destructive of the whole plan of the structure of the atmosphere disclosed by the observations.

The difference between the two regions is that in the lower region, the troposphere, the isothermal surfaces may be roughly described as horizontal, and in the stratosphere as vertical. The sudden transition from the horizontal sheet to the vertical sheet is the astounding feature which is exhibited at the tropopause all over the world; and as in the region of vertical isothermal surfaces the horizontal temperature gradient is from the equator towards the pole, and therefore opposite to that of the region where the isothermal surfaces are nearly horizontal, the opportunity of drawing effective attention to the paradoxical result of the equatorial region providing the coldest place on earth ought not to be missed. There is at least as much difference of temperature in the stratosphere between the equatorial region and the pole in one direction as there is at the surface in the opposite direction, at any rate in the summer, and if the upper region can be legitimately called isothermal, why not the surface layer?

It is remarkable that the chapters on the upper air draw their information from observations of the air of Europe. Our atmosphere has indeed been worn rather threadbare. We have drawn a number of conclusions from the European observations. They are largely confirmed by observations in Canada, and we are particularly anxious to know whether they are confirmed or contradicted by observations in the United States. So far as information has reached us, it would appear that the results for the United States show rather high temperatures and high pressures when brought into comparison with the observations of the rest of the world. That would indicate a sort of dislocation of the equatorial or tropical high pressure to the northward over the southern United States, at least in the summer. And as such a dislocation had already been indicated, years before the recent investigation of the upper air, by Teisserenc de Bort in his computed map of isobars at 4000 metres (which agrees in an extraordinary manner with the results of modern observations), we are naturally very curious to have compendious summaries of all the results for the United States, and to know whether the generalisations which we have made apply to them.

This brings to mind a certain shyness about tackling unsolved problems which other people have recognised as fundamental but have failed to solve. This shyness is a little bit characteristic of Prof. Humphreys's work, and is a rather disappointing feature of the book. One forms the idea of a workman with a bag of nice, sharp physical and mathematical tools who undertakes with unerring success, any job that can be done with the available implements, and who prefers to pass by, with some irreproachable but vaguely general remarks, a number of old problems which Maury, Redfield, Espy, Loomis, Ferrel, and, later, Bigelow tried to solve. This is the more to be regretted because Prof. Humphreys's work is really original; it is not compilation. We get the impression that, while possessed of almost unexampled facility for dealing with it, he has preferred to pass by on the other side when anything controversial came within sight and there was a chance of a row. As an example, optics, which is an amenable subject, gets a whole part, while sound, which is also physics, but not amenable, receives only a casual reference, and in the chapter on the atmospheric circulation, on the question of what actually steers the wind, a good deal of space is given to discussion of the deflection due to the earth's rotation and change of velocity with latitude, which is true enough in the vague sense that it supposes the air to be free to find its path "under no forces," or without constraint. We should prefer to start with the fact that in actual practice wind is never free from the constraint of the distribution of pressure. Some meteorologists still require to realise that if it were not for a certain suitable constraint a train that started due north from New Orleans would presently find itself running into the Atlantic Ocean at a speed of a hundred or two hundred miles an hour. Nobody really expects it to behave in that way; the flange sees that it does not: no more does the wind; pressure takes care that it does not. Hence the introduction of unconstrained motion on the earth's surface requires an apologia that is seldom forthcoming.

We should like to pass on to Prof. Humphreys the remark of a London street arab who found us on one occasion hurrying to a cab to reach some function that insisted upon an academic robe which we were concealing so far as anything scarlet can be concealed: "Put it on, sir; don't be shy." We share the feeling and appreciate the dilemma, but we feel sure that if Prof. Humphreys were less afraid of saying something that his academic colleagues might criticise, he could render great service to the difficult science of meteorology, even if the critics were correct. Although ultimately the physics of the air is the same as that in the laboratory, the physical problems of the atmosphere require special intellectual tools for their solution, and the use of new tools requires courage. One can, of course, keep out of range of reproach for unorthodoxy or misconception when treating the questions that really move the meteorological world, but it is not so helpful as the bolder course. What we should like to know is almost as important to a subject as what we do know beyond dispute.

It is only when we reach part iv.—"Factors of Climatic Control"—that the author becomes really argumentative, and thereby most interesting, in suggesting and endeavouring to demonstrate that dust projected into the stratosphere by volcanoes is the efficient cause of prolonged changes of temperature that express themselves in climatic changes, after examining and rejecting all the other explanations which have been proposed. On reaching those chapters we feel once more in the fresh, free air, and the solicitude for the academic robe is disregarded. The oppression of the four walls of the laboratory vanishes. There is a sense of relief when the author boldly calculates the rates of fall of dust under Stokes's law without taking account of the counteracting influence of eddy motion which is so potent throughout the atmosphere in keeping solid and liquid particles in suspension. It would tax our space too much to consider why the stratosphere in particular should have to carry this additional burden, but the whole subject is full of interest, and now that he has taken off the academic gloves and faced so controversial a question as the cause of the Ice-age we look to Prof. Humphreys to let us have his views about various problems of the circulation of the atmosphere in general, and of cyclonic circulations in particular, to which in the past the meteorologists of the United States have made some notable contributions which might now be reviewed and perhaps revised. Meanwhile he deserves our hearty thanks for a very useful and handy book of reference indispensable for the meteorological library.

NAPIER SHAW.

New American Text-books of Botany.

(1) *General Botany for Universities and Colleges.* By Prof. Hiram D. Densmore. Pp. xii+459. (Boston and London: Ginn and Co., 1920.) 12*s.* 6*d.* net.

(2) *Laboratory and Field Exercises for "General Botany."* By Prof. Hiram D. Densmore. Pp. viii+199. (Boston and London: Ginn and Co., 1920.) 3*s.* 9*d.* net.

(1) PROF. DENSMORE'S avowed intention is to "furnish both student and instructor with a helpful and connected statement of the more important facts and principles of modern botany." It is but rarely that an elementary text-book meets the requirements of teacher and student in equal degree; in striving after this ideal, Prof. Densmore has, one fears, fallen between two stools. For the student the statement is not sufficiently connected, and the teacher of university grade should not require help in regard to such elementary matter as fills the bulk of this book.

The discontinuous character of the text is aggravated by a noticeable lack of balance. Thus while the structure of stems, leaves, and roots is disposed of in thirty-three pages, an equal amount of space is devoted to an account of plant-breeding and evolution, which, moreover, deals principally with such modern developments as Mendelism and the mutation theory, touching but lightly on the more general aspects of evolution. The discussion of floral construction is inadequate, and the same remark applies to the chapter on fungi, which, in addition, is badly arranged, and gives no clue to the phylogeny of that group, the "simple classification" on p. 243 being in reality no classification at all. The author's didactic methods are often peculiar. Growth-movements are fully discussed before any account has been given of growth itself. The complex woody stem is described before the simpler herbaceous type. Part iii. ("Representative Families and Species of the Spring Flora") would fit better into a book of Nature-study than it does into the present volume, where its usefulness is not apparent. It is only fair to note that some of the foregoing criticisms are repelled in advance in the author's preface, where he professes his adherence to a "biological, economic, and ecological point of view" in preference to a taxonomic or phylogenetic outlook.

Opinions differ widely as to the best form of elementary botanical course, but most teachers will agree that it is better to concentrate even unduly on one aspect of the science—say, phylogeny, physiology, or even taxonomy—than to adopt the kaleidoscopic method favoured by Prof. Densmore, whose hint as to the lack of interest shown by beginning students in most aspects of botany (the fortunate exception being "cellular biology") is significant. It is claimed that the sections dealing with structure follow the teachings of the "newer anatomy"; in the absence of a precise definition, one is left in doubt as to how far this claim is justified, but the reviewer has searched in vain for any important anatomical facts or theories which have not figured in our elementary text-books for many years past. No mention whatever is made of palæobotanical evidence, which one would naturally expect to have an important bearing on the "newer anatomy."

There are a number of obvious inaccuracies which will doubtless disappear in a second edition. Thus the toadstool in Fig. 146 which purports to be *Amanita muscaria* is clearly a Coprinus; Funaria is said to be diœcious; Kerner von Marilaun appears as "Körner"; *"Nasturtium Tropaeolum"* is an unwelcome *combinatio nova*. Among good features of the book may be noted the section on the seasonal life of certain common plants, and the inclusion of Chlamydomonas as a type for detailed study. Without a first-hand knowledge of the requirements of American universities and colleges, it is difficult to say how this book will be received in its own country. There is not likely to be much demand for it on this side of the Atlantic.

(2) The book of practical exercises, though open to the same general criticisms as its companion volume, is more satisfactory on the whole. Some important subjects, such as sieve-tubes, the stoma, the ascus, and the angiospermic ovule, might have been dealt with in more detail.

M. D.

Theban Tombs.

(1) *The Tomb of Amenemhet.* (No. 82.) Copied in line and colour by Nina de Garis Davies, and with explanatory text by Dr. Alan H. Gardiner. (The Theban Tombs Series. First and Introductory Memoir.) Pp. vii + 132 + xlvi plates. (Published under the auspices of the Egypt Exploration Fund.) (London: George Allen and Unwin, Ltd., 1915.) 2 guineas net.

(2) *The Tomb of Antefoker, Vizier of Sesostris I., and of his Wife, Senet.* (No. 60.) By N. de Garis Davies. With a chapter by Dr. Alan H. Gardiner. (The Theban Tombs Series. Second Memoir.) Pp. iii + 40 + xlviii plates. (London: George Allen and Unwin, Ltd., 1920.) 2 guineas net.

THE importance of the series of painted tombs at Thebes for the history of civilisation is at last being adequately met by publication. A "Theban Tombs Series" has been started by Mr. Davies and Dr. Gardiner with the scrupulously accurate copies by Mrs. Davies. The style is adequate to every requirement, without the fastuosity of luxurious book-making. The pictures of an age that overlaps the most brilliant civilisation of prehistoric Europe, about 1500–1200 B.C., are worthy of the fullest record that can be made.

(1) In this volume there is much to illustrate Egyptian thought and ideas. The conventions of the drawing arise from the need for a complete and absolute figure of each object, regardless of the limitations of the view of it; if it were not complete, the magic value of the figure would be impaired or lost, and a merely relative view would not suffice. At first, in the pre-pyramid times, the paintings of objects were the exact size of the object. A discussion of the magic value of paintings ends in an open verdict; those entirely hidden in the burial chamber could only be magical; while biographies and other matter which was prominent to the public were memorial. The crippling of paintings by imperfect figures of noxious animals, or erasures of important parts, shows how much magic value was considered. The eldest-son priest was effaced, to hinder the value of offerings; the eyes of figures were picked out, that they might never see again; the drawing of the surveyor's measuring-rope was cut across, that he might never use it in a future state. The whole ritual of funeral scenes is discussed here, and also the meaning of the constant formula "an offering which the king gives." The likely meaning of this is omitted, however; the regular system of food-rents, or right of boarding for the king, which we find elsewhere, may well have existed in Egypt; a later appropriation of this for the service of the dead would constitute an offering legally by the king.

(2) This volume deals with almost the earliest painted tomb at Thebes. The scenes are the usual domestic, hunting, and funeral subjects known elsewhere, but many of the phrases of the workmen are very lifelike. The figures of fallow deer show how much the desert fauna has changed. It is to be hoped that the editors will publish a large part of the hundred tombs which need their care.

W. M. FLINDERS PETRIE.

Our Bookshelf.

Hittite Seals: With Particular Reference to the Ashmolean Collection. By D. G. Hogarth. Pp. xi + 108 + x plates. (Oxford: At the Clarendon Press, 1920.) *3l. 13s. 6d.* net.

THE opening out of the history of man during the last thirty years has been quite as surprising as the growth of other branches of science. In place of trying to extract some further ideas from the ragged relics of literature, we have learned how to understand a civilisation without any intelligible documents, and to place the remains of it in order so as to show its abilities and to tell its course. The volume here noted deals with a branch of the Hittite work which has a wide historical interest, for the small seals are distinctive in their styles, and serve to show connections with work in other lands; they also were readily carried to other countries, and thus are links with neighbouring civilisations.

Mr. Hogarth has a close knowledge of the region involved. He outlines the periods of Hittite history, and the various movements of peoples connected with it from 2000 to 600 B.C., in a masterly summary, which is very necessary for ethnological study. He then details the varied forms of the seals, and the subjects of the 335 specimens in the fine collotype plates. The classification by periods is the fruit of the work. It is notable that the button-badges of the Syrian invaders of Egypt (Sixth to Tenth Dynasties) and the labyrinth and frets of foreign origin (Sixth to Seventeenth Dynasties) seem to have been over and past before the rise of Hittite styles. The doubt (p. 23) as to the early use of the wheel in gem engraving is settled by work in Egypt so far back as the Eleventh Dynasty. The volume has the noble traditions of the Clarendon Press; but can students afford to support bibliophily as well as archæology in these times?

Zoomikrotechnik: Ein Wegweiser für Zoologen und Anatomen. By Prof. Paul Mayer. (Sammlung naturwissenschaftlicher Praktika. Band ix.) Pp. vii+516. (Berlin: Gebrüder Borntraeger, 1920.) 64 marks.

THE treatment of the subject of zoological technique in this book follows closely the lines of Lee and Mayer's well-known "Grundzüge der mikroskopischen Technik," the last (fourth) edition of which was issued in 1910; indeed, the present volume may be regarded as the new edition of that work.

In the first seventeen chapters directions are given for various methods of killing, fixing, hardening, staining, injecting, embedding, and sectioning organisms and tissues, for mounting whole specimens and sections, and for decalcification. The six remaining chapters deal with the technique of the cell, of eggs, embryos, and larvæ, and with histological methods for vertebrates and invertebrates. In a number of cases the account of a method is too short to be a real guide, and the reader is referred rather too often to "Lee and Mayer," or to some other book, for details which he might reasonably expect to find in this volume. For instance, in a book intended for anatomists, instructions should have been given for making up Kaiserling's solution, but instead there is a reference to "Lee and Mayer." A number of methods which would have been useful to zoologists have not received notice—*e.g.* methods for the culture of tissue and of Protozoa, the employment of iodine solution during the examination of intestinal amœbæ, and the examination and staining of spirochætes. But the omissions are relatively few, and the veteran professor is to be congratulated on the issue of this useful guide, to which he has added an excellent index.

Meteorological Office—Air Ministry: British Rainfall, 1919. Pp. xxviii+268. (London: H.M.S.O., 1920.) 12*s.* 6*d.* net.

As a consequence of the absorption of the British Rainfall Organization by the Meteorological Office this volume is, for the first time, printed by the Stationery Office and issued as a Government publication. It contains a preface by Sir Napier Shaw and an introductory chapter by Mr. Carle Salter, both dealing with the change of responsibility. The work is divided into four parts. Part i. refers chiefly to organisation. Part ii. gives details as to evaporation and percolation in 1919, and as to the distribution of rainfall in time, embracing wet spells and droughts; also monthly and yearly rainfall tables at 348 stations in the British Isles, together with monthly rainfall maps and a second monthly map showing the percentage of average fall, and data of the seasonal rainfall of 1918–19.

Part iii. contains a general table of total rainfall in 1919 at 4893 stations in Great Britain and Ireland. Part iv. has an article on the effect of rainfall on the saturation-level in the chalk at Chilgrove, West Sussex, from 1836 to 1919, by Mr. D. Halton Thomson, also an article on the exposure of rain gauges by Mr. M. de Carle S. Salter, which should be read by all rainfall observers. There are many features not ordinarily recognised, especially the exposure during the winter months, when higher winds are experienced than during the summer months, the wind causing a factor detrimental to the correct measurement and calling for care in the position of the gauge so as to safeguard it against over-exposure and to avoid defects due to wind-eddies.

C. H.

British Plants: Their Biology and Ecology. By J. F. Bevis and H. J. Jeffrey. Second edition, revised and enlarged. Pp. xii+346. (London: Methuen and Co., Ltd., 1920.) 7*s.* 6*d.*

THE revised and enlarged edition of "British Plants" provides a most useful handbook on general ecology, not only for the trained botanist, but also for the general reader who is interested in plant life. The outlines of the subjects are sketched in a suggestive manner with a minimum of technicalities, and sufficient general morphology is included to make the matters clear to the non-botanist. The first part of the book deals with environment and its influence on vegetation, the effects of climate, water, and soil receiving special attention. The second part gives general biological information, the section on the defensive equipment of plants gathering together a good deal of scattered knowledge. The last part treats of the evolution and present distribution of the British flora, and though one may join issue with the authors on certain points of detail, the broad outlines are clearly presented.

The book is fully illustrated, though some of the plant drawings would bear improvement—*e.g.* the underground rhizomes of couch-grass and mint, which lack distinctiveness and clearness. The authors are to be congratulated on bringing up to date a work which puts forward ecological matters in such a simple and attractive style.

W. E. B.

Letters to the Editor.

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

The International Research Council.

THE issue of the *Times* published on March 8 contains an article headed "The Progress of Science: Revolt against Super-Organisation." A few words of comment are necessary, though the task is disagreeable owing to the general tenor of the article, which in parts is frankly abusive and in others misleading. Its chief invective is directed against the International Research Council. This, according to the author, is to be "the supreme body in all the affairs of science," and he follows up this product of his imagination by enumerating in the same sentence the avowed objects of the International Research Council, placing a pure invention of his own in juxtaposition to the actual functions of the body concerned so as to leave the impression that both have equal authority.

The International Research Council was founded in the first instance through the action of the Royal Society and the Academies of Paris, Italy, Brussels, and Washington. Its object was to reorganise international work which had come to a standstill through the war, and to extend it where found desirable. The question as to the time at which former enemy countries should be admitted is a matter for argument, and it may be the policy of the *Times* to urge their immediate inclusion in the interests of the general peace of the world. Recent incidents at a meeting in Paris at which a German professor took part do not confirm this view, but the question has really nothing to do with the purpose which the article pretends to discuss. It should not be forgotten, however, that a friendly personal intercourse is an essential condition of the success of international conferences. This is recognised by the countries neutral during the war, which have nearly all accepted the invitation of the International Research Council to take part in this common enterprise.

The International Research Council has initiated the formation of unions for the conduct of scientific work. In the subjects of astronomy, geodesy and geophysics, and chemistry such unions are actually at work, and two others have been formed. Once an international union is established it becomes autonomous, and conducts its work without interference from the International Research Council except in a few matters in which a common policy is desirable.

Everyone knows that the decisions of an international conference are only advisory, and have no binding force on the separate countries. Representatives taking part in the conference report to the home authorities concerned, who act as they think fit, accepting, no doubt, in general such recommendations as have secured practical unanimity. At a recent meeting in Brussels certain countries desired to initiate the formation of an International Union of Biology, and their representatives tentatively drew up some statutes. These were submitted to a competent body in this country, which reported unfavourably, and there the matter ends so far as Great Britain is concerned. This does not, of course, prevent France, Italy, the United States, and other countries from forming a Union of Biology if they wish. I fail to understand where the grievance of the *Times* comes in.

ARTHUR SCHUSTER,
General Secretary of the International Research Council.

The Constitution of the Alkali Metals.

IN a recent letter (NATURE, February 24, p. 827) attention was directed to positive rays of metallic elements generated by means of a heated anode by which lithium (atomic weight 6·94) was demonstrated to contain two isotopes 6 and 7. The mass spectrograph has now been successfully applied to the analysis of these rays and the investigation thereby extended to the heavier members of the group.

The method presents some peculiar technical difficulties, and the intensity of the lines yielded is very poor in comparison with that of the "gas" lines produced by the ordinary discharge tube. On the other hand, the arrangement is such that *none* of these ordinary "gas" lines appear at all, so that any line, however faint, if satisfactorily confirmed by repetitions with different fields, is conclusive evidence of the presence of metallic atoms of corresponding mass in the salt employed on the heated anode.

Sodium (atomic weight 23·00) is the easiest metal to deal with; its mass spectrum consists of a single line only. From the known values of the fields employed this line is in the position expected from the atomic weight; it is therefore assumed to be exactly 23, and used as a standard comparison line.

Potassium (atomic weight 39·10) gives a strong line at 39 and a very weak companion at 41. These figures are integers within about a quarter of a unit when compared with sodium 23. The relative intensities of the lines are not inconsistent with the accepted atomic weight. Potassium therefore probably consists of two isotopes 39 and 41.

Rubidium (atomic weight 85·45) gives two lines two units apart of relative intensity about 3 to 1. Comparison with the potassium line 39 gives these the masses 85 and 87 to within a fraction of a unit. As these values are in excellent agreement with the accepted atomic weight they may be taken, provisionally at least, as the weights of the two isotopic constituents of rubidium.

The mass spectra obtained from cæsium (atomic weight 132·81) have so far exhibited only one line, which when measured against the rubidium lines indicates a mass 133. The intensity of this line leaves much to be desired, but it is sufficient to point to the conclusion that if, as the atomic weight would lead one to expect, another isotope of cæsium exists, it is present in proportions of less than 5 per cent.

F. W. ASTON.

Cavendish Laboratory, March 12.

The Designation of Vitamines.

IT is often said that a rose by any other name would smell as sweet but in chemistry this is not the case; the name is of consequence and the choice limited. I am glad that Prof. Liversidge takes exception in NATURE of March 10 to the sufficiency of the suggested dropping of the "e" from "vitamine"—the sting is still left in the "amin" tail; moreover, the word should be got rid of altogether, as it is but a monument of a gross experimental blunder.

In my early days one of the most valuable lessons I learnt was from the late Prof. A. W. Williamson, one of the keenest intellects of his day among chemists. He always insisted that we did well to use non-committal names—names which did not give expression to a view open to question but were simply descriptive of some recognisable character in no way open to doubt. No better illustration can be given than the use of the name "carbamide" for urea, actually enforced by the Chemical Society. "Urea" is non-committal but absolutely significant of the origin of the substance, nothing more; "carbamide" is suggestive of a particular structure, of a view which, so long as I can remember, has not been in accordance with the facts and is now, I suppose, fairly generally abandoned, though the error is still perpetuated in the text-books—but one of the main purposes text-books serve is the perpetuation of error. Other cases might be quoted; time was when "constitutions" were settled on paper and not a few names are survivals of the practice.

In a course of Cantor lectures on "Food Problems" which I gave in May, 1919, I suggested the use of the term "advitant" in place of "vitamine." A word of good clang, its meaning is clear and will be obvious to most; the substances it is intended to cover *are* necessary to life and we may as well say so, though we have not the faintest idea what they are. HENRY E. ARMSTRONG.

Relativity and the Velocity of Light.

MR. BARTRUM'S excellent letter on p. 42 of NATURE of March 10 has done good service in extracting an explanation from Dr. Jeans, but the latter will forgive my saying that his position is not clear yet, at least not clear to me. Briefly thus:

(*a*) If we are able to compare the velocities of two single light journeys, one of which may be under normal conditions and therefore known, surely we have determined the other.

(*b*) I cannot see that Majorana's interesting experiments prove more than that the propagation of light has the characteristics of wave, and not projectile, motion.

(*c*) I admit Dr. Jeans's equations (1), (2), and (3), but I can see no merit in afterwards introducing v. If they are true for all reasonable values of u, what more is gained by writing $u+v$ instead of u? Are they not the same thing? OLIVER LODGE.

The Peltier Effect and Low-temperature Research.

FROM certain considerations emphasised by me in the *Phil. Mag.* for December (Supplement), 1876, especially § 33, ser. v., vol. ii., p. 538, about true contact e.m.f., I concluded that such forces are intimately connected with electrical resistance; good conductors fail to get a grip on the electricity so as to propel it effectively, while the grip of insulators is tremendous. Consequently it is probable that at any temperature at which electric resistance ceases, the Peltier effect will cease also. OLIVER LODGE.

The Nature of the Emulsoid Colloid State.

THE publication in the Transactions of the Chemical Society for December last of the latest of the extremely valuable and interesting investigations by Prof. J. W. McBain and his collaborators on soap solutions leads me to direct attention to a hypothesis as to the nature of the emulsoid colloid state which I have briefly indicated in a technological paper on "Colloidal Fuels" (*Journ. Ind. Eng. Chem.*, vol. xiii., p. 37, 1921). The stabilising colloids used in these fuels belong to a class of bodies forming emulsoid sols and gels in *non-aqueous* systems, *e.g.* in hydrocarbon oils. The parallelism between certain such non-aqueous systems and aqueous emulsoids has struck many observers (notably M. Fischer) and caused considerable doubt as to the validity of the application of ionisation theories to the emulsoid colloids. Certainly it would appear that any theory of the emulsoid systems must explain why sodium oleate forms sols and gels with water, whereas aluminium oleate does so with benzene.

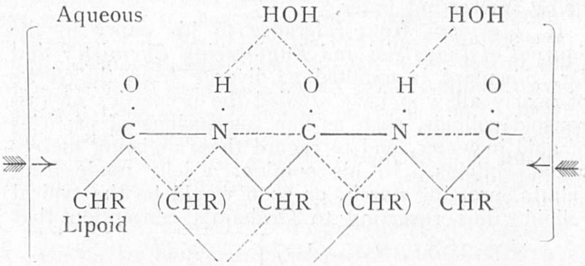
The theory of micellar orientation supported by McBain appears to suffer in this respect, that the "micelle" postulated is already a micro-colloid system, and the colloid properties are already present in the "micelle." A consistent theory of emulsoids must not only be in agreement both with the physical properties (viscosity of sols, gelation, elasticity of gels, hysteresis, etc.) and with the facts as to chemical constitution (polysaccharide character of starches and celluloses, polypeptide character of proteins, fatty acid salts for soaps, etc.), *but it should also show the physical properties developing from the chemical composition and constitution.* If colour and selective absorption flow from chemical composition and constitution, there appears no reason why cohesion and selective adsorption should not do so also. The suggestion which I put forward was stated as follows (*loc. cit.*, p. 42):—"Such gels—(heat reversible) not coagula—may be imagined as very tenuous web-works, or foams, the mesh or walls of which are very probably sub-molecular in dimensions, or the whole mass of the colloids forms one 'molecule' uniformly dispersed through and partially dissolving the solvent. By partially I mean that only part of the 'molecule' of the emulsoid is consolute with the solvent or dispergent, while the other part of it is insoluble, and its atoms tend to unite, forming a semi-rigid framework."

The hypothesis proposed does not regard micellar orientation (and attraction) as primarily responsible for emulsoid sols and gels, but rather sub-molecular (or transmolecular) orientation of definite atom-groups, entirely in the sense of the theory of molecular orientation due to structure proposed for surface and interfacial tension phenomena by W. B. Hardy (Proc. Roy. Soc., vol. lxxxvi., A, p. 610, 1912), J. Langmuir (Journ. Amer. Chem. Soc., vol. xxxviii., p. 2221, 1916; *ibid.*, vol. xxxix., p. 1848, 1917), and W. Harkins (Journ. Amer. Chem. Soc., vol. xxxix., pp. 354 and 541, 1917).

The genesis of a micelle, as plurimolecular unit of a colloid system, may be regarded as a consequence of equilibrium, usually incomplete, between homochemical solution forces and heterochemical forces, the former tending to dissociate and decompose the chemical molecule, the latter resisting decomposition. In the case of proteins the most probable general type of linkage, according to H. A. Plimmer ("Chemical Constitution of the Proteins," part ii., p. 2), is of the form

$$NH_2.CHR.CO.(NH.CHR.CO)_n.NH.CHR$$
$$\qquad\qquad\qquad\qquad\qquad\qquad | $$
$$\qquad\qquad\qquad\qquad\qquad\qquad COOH$$

where n refers to the degree of polypeptide condensation and R is an alkyl or other substituent group. On the hypothesis suggested here we may, imperfectly, represent the redistribution of this in the presence of water for the polypeptide chain by



In this the arrows indicate the direction of an imagined plane or intra-molecular interface *i* separating the hydrophile groups $\begin{array}{c}\mathrm{C—N} \\ \cdot \quad \cdot \\ \mathrm{O} \quad \mathrm{H}\end{array}$, which are consolute with water (in virtue of residual affinities tending to complete the amino- and carboxyl groups), *from* the hydrophobe or hydrocarbon groups —CHR. Not only in one and the same protein molecule, but also to a variable extent between molecules, we may admit that this primary orientation leads to mutual attraction between water-soluble and water-insoluble groups respectively. Without any actual cleavage of the molecule, we have orientation and a stratichemical field of force which is of a similar character, in essence, to crystallisation, but results in incomplete instead of complete equilibrium. The hydrocarbon or lipoid atom groups will approach the fluid on the solid state according to molecular weights and constitution; hence the system may be likened, in one aspect, to a sub-molecular emulsion, the lipoid groups tending to form interconnected sheets of atom-groups necessarily permeable to water and water solutes, although mechanically developing a stress resisting rupture in virtue of the fields of attraction and repulsion induced. The micelles are the smallest plurimolecular units thus built up.

Applied to soaps, we have similarly a mutual attraction and solution of the hydrocarbon portions of the fatty acid radicles, without cleavage from the water-soluble portion, which dissolves and ionises. The passage of ionised micelles "through the open network of the gel as freely as through the sol" (Laing and McBain, *loc. cit.*, p. 1519) appears quite consistent with the hypothesis now suggested. Further, the form of the micellar aggregates—strings, sheets, networks of molecules—will, on this view, be a function of the original molecular constitution operating through intra-molecular orientation, and modified by ionisation and tautomerism, where these occur. The quasi-solubility in water of sodium, etc., soaps, being associated with ionisation, passes to insolubility in water with the non-ionising calcium, aluminium, iron, etc., soaps, when the solubility of the fatty acid portion (or hydrocarbon group) becomes dominant, and soap sols in non-aqueous solvents result. The stiffening to gels here with increased concentration and lowered temperature may be due to orientation of both the hydrocarbon and the metallic residues respectively, of the latter either directly or as oxides, these being solids at such temperatures.

In general, it is submitted that the present hypothesis gives a more generalised basis of explanation of what McBain regards as "not yet explained" (*loc. cit.*, p. 1518), viz. "the stable existence of any colloidal aggregate." S. E. SHEPPARD.

Research Laboratory, Eastman Kodak Co.,
Rochester, N.Y., January 18.

THROUGH the kindness of the Editor I have been given an opportunity of commenting upon the speculations advanced by Dr. S. E. Sheppard in the foregoing interesting letter.

It is evident from reference to his paper in the *Journal of Industrial and Engineering Chemistry* that Dr. Sheppard is tempted to diverge from the views of nearly all who have studied the properties of suspensoid colloids, such as fine suspensions of particles of gold in water, and to regard these as being merely pseudo-colloids. In his opinion, a jelly made from gelatin, protein, starch, or soap would be the typical colloid, thus reverting to Graham's conception that it is the substance, and not the physical state of subdivision, that makes a colloid.

It is impossible to exclude ionisation hypotheses from colloid chemistry now that it has been demonstrated that soaps in colloidal form are excellent conductors. At the same time we are quite clear that a theory of gels cannot depend upon ionisation phenomena, since gels occur in non-aqueous solvents which possess no measurable conductivity.

It is difficult to understand exactly what is meant by some of the technical terms used or coined without definition; but apparently Dr. Sheppard's conception of a stable colloid is a substance which contains atoms or atomic groupings, commonly found in chemicals which are insoluble in the solvent under discussion. For example, in aqueous sodium palmitate the long paraffin chain is regarded as being in itself insoluble in water, in contradistinction to the sodium atoms and ions. This is considered to result in a tendency for these hydrocarbon chains throughout the solution to become linked to each other through the residual affinity of the paraffin part of the molecule, to form sheets of molecular network co-extensive with the solution. The sodium end of each molecule is regarded as "dissolved" and subject to ionisation.

This conception is sufficiently elastic to conform to many of the facts, but surely such a word as "dissolved" loses its significance when applied to a solution in which both "undissolved" and "dissolved" parts of the molecule are present in a state of molecular subdivision. Thus, in the case of an aqueous solution in which gold is present in the form of single atoms—a case which has been very nearly realised—the gold would not be regarded as dissolved in the water, since gold and water are "heterochemical." The modern or current conception is certainly that this would be a true solution of gold, although highly supersaturated. It is evident that the difference is one of words, and not of scientific fact.

Again, it would be difficult to explain on Dr. Sheppard's conception the existence of gels such as that of rubber in benzene, in which surely every part of the hydrocarbon must be considered potentially soluble or "consolute" with benzene. Further, on what chemical grounds could one predict the formation of a gel of cadmium in alcohol?

I cannot but feel that even this conception of continuous open molecular network as constituting the typical colloid still leaves unexplained the stable existence of the colloidal aggregates of sols as distinguished from gels. In the case of an ordinary soap solution or sol, for example, perfect reversible equilibrium prevails, and yet the soap does not exist as "a continuous, semi-rigid framework," nor yet as single, independent molecules—that is, as crystalloid—since when in the latter condition it exhibits familiar crystalloidal properties such as osmotic activity. Hence our conclusion is that the soap is largely in the form of particles, each an aggregation of large numbers of molecules. Miss Laing found that there is a very ready change from sol to gel without alteration of either conductivity or osmotic activity. We seem forced, therefore, to conclude that the gel is built up from the same colloidal particles as the sol.

Similarly, in Svedberg's example of cadmium or cadmium oxide in alcohol, which at rest forms a jelly but on stirring reverts to a fluid sol, the colloidal particles of the sol must undoubtedly be those of the gel also. In this case the individual colloidal particles are presumably crystalline, in analogy with the experimental results recently obtained in Sherrer's X-ray investigations.

On the other hand, such colloids as gelatin have not indicated any regular pattern when examined by X-rays. A fully developed network of oriented molecules such as Dr. Sheppard describes should give indications analogous to a crystalline structure when thus examined. This X-ray method of investigation is being applied in another department of the University of Bristol to the various forms of soap solutions. It is hoped also to obtain fresh light on the problem by the experiments now being carried out by Miss Laing on the conduction of continuous current through soap jellies.

Dr. Sheppard's demand that any "consistent" theory of colloids should permit of the deduction of all the physical properties from the chemical formula alone, appears to over-estimate the extent to which the manifold physical properties of gold and silver sols of different degrees of subdivision and colour can be deduced merely from the knowledge of the chemical formulæ of the metals. In conclusion, I think his idea is at present too vague and not sufficiently in accord with such facts as those mentioned to be likely to prove more fruitful than the one it seeks to replace, incomplete as the latter is in the absence of further experiment.

JAMES W. MCBAIN.

The Chemical Department, University of Bristol, February 24.

The Production of Living Clavellina Zooids in Winter by Experiment.

IN a recent publication ("Sea-temperature, Breeding, and Distribution in Marine Animals," Journ. Mar. Biol. Assoc., vol. xii., No. 2, p. 351) the present writer showed that there was every reason to believe that the hibernation phenomena in many marine animals are purely temperature effects. In order to test this view the positions of sixteen good colonies of the beautiful Ascidian *Clavellina lepadiformis* were marked on September 1, 1920, on the wooden piles of the West Wharf, Great Western Docks, Millbay, Plymouth. This Ascidian usually appears on these piles about the end of May and dies down about the end of October, and has never been recorded in winter. On September 15 and 30 the piles were again visited and a record was made of those colonies which had survived the marking. The positions of the colonies were found to be shown effectively by three long wire nails driven into the piles on the outside of the colonies at the apices of imaginary triangles. On February 23 last the laboratory collector, Mr. Wm. Searle, who assisted in the marking of the colonies, visited the piles at the West Wharf and took careful scrapings between the nails marking the positions where Clavellina colonies were seen in September, 1920.

The material obtained remained in the collecting honey-jars on the floor of the laboratory until 8 p.m. of February 24. It was then examined, and anything like a resting stage of an Ascidian was picked out, cleaned a little, and transferred to clean water in a glass dish. On February 25 at noon the material was put into a warm room at a temperature of about 61° F., and distributed in a number of finger-bowls in ordinary tank-water passed through a Berkefeldt filter.

Little attention was given to the bowls beyond changing the water on February 28, until March 1, when a distinct Clavellina zooid was found in one dish and a bud in another. From that date onwards the number of zooids and buds has increased, and at the latest observation made on March 8 there were twelve living zooids or well-developed buds and two well-developed zooids had been preserved. From the beginning of the experiment to March 1 the temperature did not fall below 60° F., and from an inspection of the thermograph records the mean temperature of the room is seen to be very nearly 61° F.; probably the mean temperature of the water in the dishes would be slightly lower. Since March 1 the mean temperature of the room and water has been slightly higher.

It is therefore highly probable that the awakening of Clavellina from the resting stage is a pure temperature effect. In this experiment tank-water was deliberately used, and it is considered highly improbable that this water can be regarded as biologically better than the water now surrounding the sleeping stages of Clavellina in the sea. There remains, therefore, only the presence or absence of some recondite chemical complex in the water as a possible factor in aiding in the awakening of this Ascidian. The existence of such a complex is, however, not regarded as probable.

Driesch has shown that Clavellina regenerates lost parts with facility, and that starving or foul water will also cause this Ascidian to absorb all its organs and pass into an undifferentiated condition. It would appear, however, that none of these factors operate during the period of hibernation, since the water at the West Wharf is undoubtedly more foul during the period when Clavellina flourishes than when it passes into and remains in the resting condition, and similar Ascidians in the same locality feed and grow during the winter. Other forms which feed in the same way, and probably on the same kinds of food, as Clavellina also flourish and grow in the same situation in winter.

It would therefore seem that variations in temperature are the normal stimuli for development and differentiation in Clavellina, and the determination of the actual point in temperature at which these changes occur should afford a useful clue in attacking the question of the underlying chemico-physical changes.

The winter resting stages of Clavellina are very simple bodies; they are flattened expansions of transparent gelatinous material (tunicin) with a mammillated surface containing a core of opaque yellow tissue—apparently undifferentiated—which shows mammillations corresponding to those in the gelatinous coat. In the development of the zooids the mammillations swell and a core of tissue extends into the swelling. The bud thus formed increases in size and differentiates into the zooid.

J. H. ORTON.

The Laboratory, The Hoe, Plymouth, March 9.

The Elementary Particle of Positive Electricity.

REGARDING the suggestions for the name of the hydrogen nucleus made by Prof. Soddy (NATURE, December 16, 1920, p. 502) and Dr. Prideaux (NATURE, December 30, 1920, p. 567), it would seem to be better to use the term "hydron" instead of "hydrion," as being shorter and more euphonious.

It may be recalled that the late Lord Kelvin used himself, and tried in vain to induce others to use, the term "electrion" instead of "electron." At this late date it seems quite unnecessary to insist on the retention of the extra syllable simply to have the word "ion" retained in the longer term unless for the sake of euphony, as in "thermion."

ANDREW H. PATTERSON.

University of North Carolina, February 19.

New Studies of Sun-fishes made during the "Dana" Expedition, 1920.

By DR. JOHS. SCHMIDT, Carlsberg Laboratory, Copenhagen.

[The *Dana* is a four-masted motor schooner of 550 tons, belonging to the East Asiatic Company of Copenhagen. His Excellency H. N. Andersen, director of the company, generously placed this vessel at the disposal of the Danish Committee for the Study of the Sea for a cruise in the Atlantic.]

THE sun-fishes (Mola and Ranzania) are undoubtedly among the most remarkable creatures which inhabit the oceans. By their peculiar shape, altogether unlike what we are accustomed to find in fishes (Figs. 1–3), their divergence in point of internal structure, and the considerable size which the best-known species attains, they have from ancient times attracted the attention of naturalists.

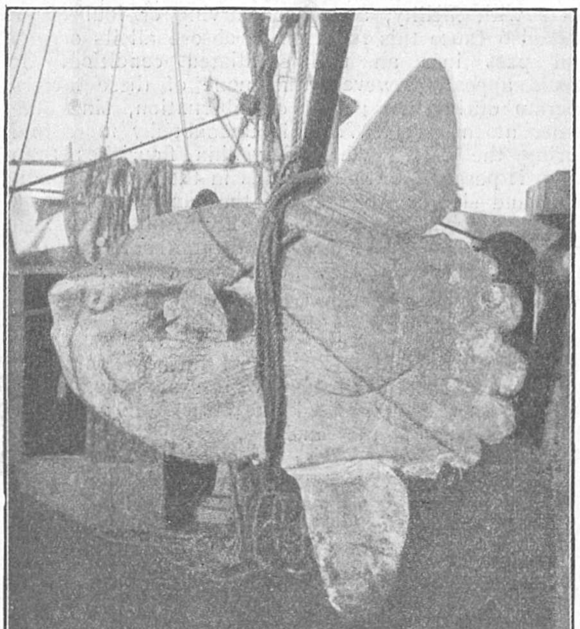


FIG. 1.—The *short* sun-fish (*Mola rotunda*). Length, 2·11 metres; weight not noted, probably about 500 kilos. (From Murray and Hjort's "Depths of the Ocean.")

Two species were known with certainty to occur in the North Atlantic: the *short* sun-fish (*Mola rotunda,* Fig. 1) and the *oblong* sun-fish (*Ranzania truncata,* Fig. 2). To these I am now able to add a third: *Mola lanceolata* (Fig. 3), a form the specific value of which has been questioned by recent authors. Though related to *Mola rotunda,* it is doubtless a distinct species, differing by the pointed tail and the number of fin-rays, as well as by several larval characters.

The oblong sun-fish attains a length of only two or three feet; the short sun-fish, on the other hand, is known to have reached a length of eight to ten feet or more, and a weight of more than a ton. It is thus one of the giants of the ocean. That the sun-fishes also possess gigantic strength is evident from a report of one of the Prince of Monaco's cruises in the Atlantic with the yacht *Hirondelle,* where we read that a large specimen —the same as that represented in Fig. 3—which was harpooned from a boat sent out from the yacht, almost pulled the boat under in its struggles

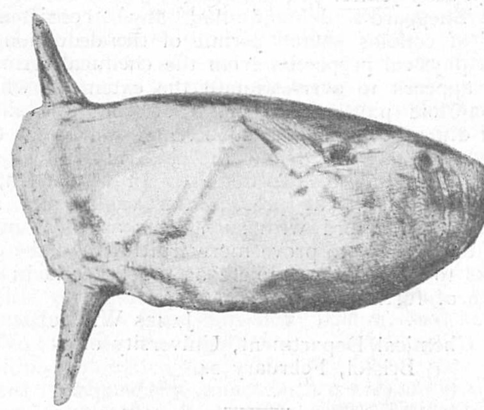


FIG. 2.—The *oblong* sun-fish (*Ranzania truncata*). Length, 0·65 metre. (From Beauregard.)

to escape. The sun-fish owes its strength to the powerful development of the muscles controlling the two large vertical fins (the dorsal and anal, shown in Fig. 1). On the other hand, the muscles generally composing the greater part of the body

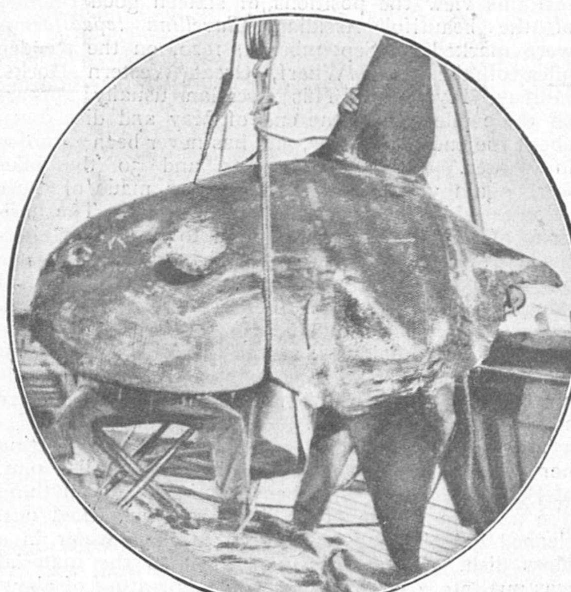


FIG. 3.—*Mola lanceolata*, a species related to the short sun-fish, but differing by the pointed tail. Length, 2 metres; weight, 285 kilos. (From the Prince of Monaco.)

in a fish, the great lateral muscles, are rudimentary in the sun-fish.

The short sun-fish (*Mola rotunda*) occurs comparatively frequently off the coasts of Western and Northern Europe, near the British Isles more especially in the summer, and in Danish waters during autumn; it has also been found near Iceland and off the northernmost coast of Norway (about latitude 70° N.). It is thus not difficult to procure specimens, and such are also to be seen in most museums. The oblong sun-fish (*Ranzania truncata*), on the other hand, is far more rarely seen in collections. It does not penetrate so far to the north as *Mola rotunda,* but has, nevertheless, been found occasionally in the waters of Western Europe and the British Isles, where its northern limit of occurrence appears to lie.

With regard to the habits of the oblong sun-fish (Ranzania) practically nothing is known. It may, however, be mentioned that it was on one occasion observed in enormous numbers at the surface of the water, at Martinique, in the West

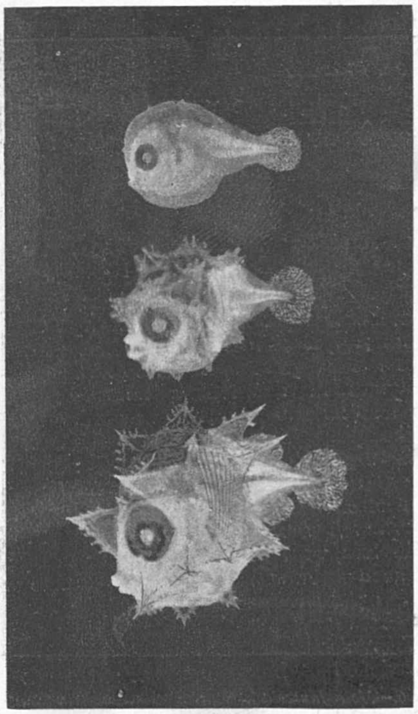


FIG. 4.—The *oblong* sun-fish (*Ranzania truncata*), larval stages. Length, *a*, 1·7 mm.; *b*, 1·8 mm.; *c*, 2·4 mm.; *a* hatched on board the *Dana* in the Sargasso Sea.

Indies. The short sun-fish is quite frequently encountered by mariners in the Atlantic. I have myself, on my cruises there, often seen it lying half sideways at the surface, with the tall dorsal fin projecting out of the water. It is not infrequently captured in the Mediterranean, especially during summer in the Straits of Messina, and it is known to feed on small forms of pelagic life. A fact of interest is that the larvæ of the freshwater eel appear to be its favourite food. The stomach, when opened, will often be found to contain eel larvæ (*Leptocephalus brevirostris*) by the hundred. There can thus be little doubt that it is one of the eel's deadliest enemies. The sun-fishes appear to be highly prolific. In a specimen of *Mola rotunda* 1½ metres long, for instance, the ovary was found to contain no fewer than 300 million small unripe ova.

The method of propagation of the sun-fishes, however, is unknown, and the tiny stages have not been identified in the case of any species. The collections made by the Danish Committee for the Study of the Sea have often brought to light larvæ which I had to refer to the sun-fishes, but it was impossible to determine to which species they belonged. On the trans-Atlantic cruise of the *Dana* in the summer of 1920, however, I succeeded in throwing light on the question, and was able to follow the

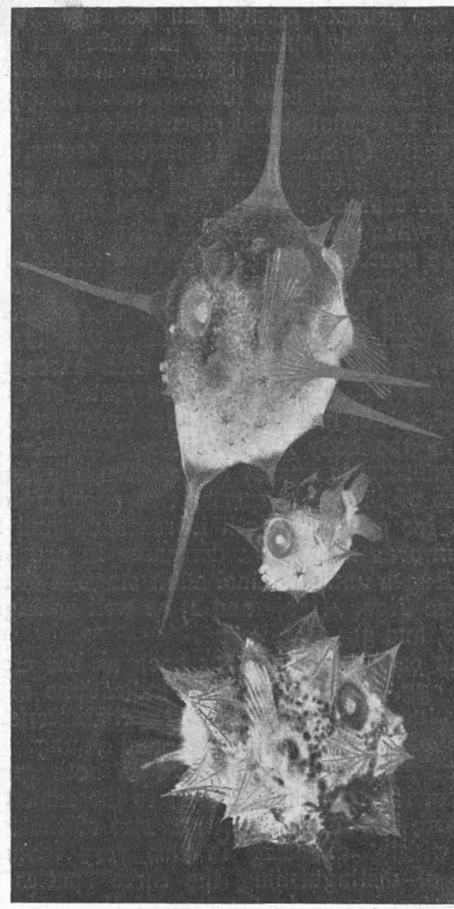


FIG. 5.—*Mola lanceolata* (*a* and *c*), *Ranzania truncata* (*b*); *c* larval, *a* and *b* post-larval stages. Length, *a*, 5·5 mm.; *b*, 3·5 mm.; *c*, 2·8 mm.; *a* and *b* same enlargement, *c* more enlarged. Note that the tail has disappeared in *a* and *b*.

development of two species for a great way back: in the case of one, to the egg itself. A full account of this needs a mass of illustration and proof material which would be out of place here. I will therefore merely give a few illustrations, reproduced from photographs, adding thereto some remarks on these larval forms, which, because of their odd appearance, are probably without parallel among fishes.

Fig. 4, *a*, shows a larva of the oblong sun-fish (*Ranzania truncata*), about 1·7 mm. long. It was hatched on board the *Dana* in the Sargasso Sea.

The eggs were found floating at a depth of scarcely 100 metres from the surface; they are small, transparent spheres, 1·3–1·4 mm. in diameter. It will be noticed that the larva, albeit clumsy to look at, nevertheless resembles an ordinary fish larva, with the usual strong tail. During the course of development, however, the tail is soon reduced, while the dorsal and anal fins, on the other hand, grow out strongly (see Fig. 5, *b*). It is precisely this reduction of the tail portion which gives the sun-fishes their remarkable, as it were truncate, appearance, as seen in Figs. 1 and 2. At a first glance it would appear as if the third species (*Mola lanceolata*) had retained the primary pointed tail (see Fig. 3). This is, however, only apparently the case; on studying the development, it will be seen that the primary larval tail here likewise soon disappears, and that the pointed tail discernible in Fig. 3 is a secondary formation. It almost seems, then, as if Nature had repented of her own strange whim, for scarcely has she deprived the species of its tail when she replaces it with a new one! All three species, indeed, undergo striking alterations in shape during development. When first hatched, the length of the larva is considerably greater than its height; but the proportions are soon reversed, and the height then exceeds the length (Fig. 5, *a* and *b*). This state of things, however, is not maintained; at a length of barely 5–6 mm. the body of the oblong sun-fish (*Ranzania truncata*) is already longer than it is high (in the case of the Mola species this does not occur until a far greater length is reached), and from now onwards the height decreases in proportion to the length until the final adult stage is attained (compare Figs. 4, 5*b*, and 2, as well as Figs. 5, *c* and *a*, and 3).

At an early stage, so far back as the embryo in the egg, we find the first indications of that spinous equipment which is so characteristic a feature of the sun-fish larvæ and young. The same spines can be recognised in both genera, thus showing that these belong to the same type; otherwise, the development and size of the spines differ widely, affording in this very feature a means of distinguishing the three species with the greatest ease. In the case of *Ranzania truncata* the spinous equipment is comparatively modest; in *Mola lanceolata*, on the other hand, the spines attain such an enormous development that at a certain stage they exceed the length of the body. Five of the spines at this stage stand out from among the rest in point of size, so much so, indeed, as to deserve the name of horns. Three of these are unpaired and set in the same plane, directed forward, upward and down, the remaining two being paired and set in a plane at right angles to the first, and pointing obliquely to the rear (Figs. 5, *a*, and 6). In all early stages the two genera are easily distinguishable one from the other by the structure of the bases of the spines, which in Mola exhibit transverse ribs, these being lacking in Ranzania.

The Mola larvæ were invariably dead when found in the net; those of *Ranzania truncata*, on the other hand, I was now and then able to observe in a living state. The upper portion of the body (the entire part above the eyes) was dark, while the lower glittered like silver. When placed in a vessel full of sea-water, the larvæ could be seen shooting through the water at a surprising speed, propelled by the extremely rapid movements of the dorsal and anal fins, but apparently with no good steering qualities. Fig. 5, *a* and *b*, shows distinctly the two fins mentioned, which are set in a manner resembling that of the blades in a ship's propeller, here, however, always placed vertically.

The larvæ were found in the open sea, not far from the surface of the water: those of Mola somewhat deeper than those of Ranzania. They

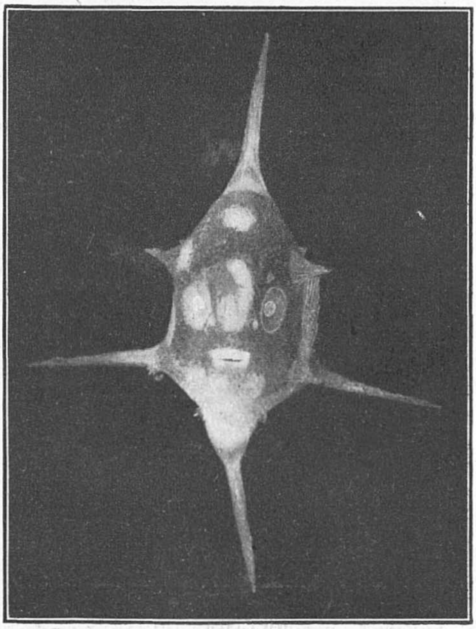


FIG. 6.—*Mola lanceolata*, post-larval stage. Length, 5 mm. Front view.

were very numerous in places, especially in the Sargasso Sea, and we have found between one and two hundred in the contents of a single net, where they are difficult enough to discern among the thousands of other small creatures. I cannot, however, go further into the question of distribution until we have been through the collections thoroughly, which is a matter of considerable time.

In the literature of the subject, tiny larvæ of the sun-fishes have, so far as I am aware, been mentioned and figured three times: First, by Sir John Richardson (1844–48)—this, strangely enough, only on account of a drawing made by the botanist, Sir J. D. Hooker, who caught the specimen in a tow-net in the South Atlantic; secondly, in 1898, by the Danes Steenstrup and Lütken, from material collected in the Atlantic by Danish sailing vessels many years ago; and, thirdly, by the Italian Sanzo, who in 1919 gave a figure of a specimen 2·8 mm. in length from the Straits of Messina. Richardson referred his—or rather Hooker's—specimen to the trunk-fishes, and termed it *Ostracion boops*; the other authors, however, realised that they were dealing with the young of sun-fishes, but were unable to make any closer determination of the species. Judging from the new material provided by the *Dana* expedition, I can now with full certainty state that all the specimens in question are larvæ of the oblong sun-fish (Ranzania). The tiny stages of the short sun-fishes (Mola), however, do not appear to have been figured or mentioned in literature up to now.

Electrons.[1]

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

IN recent years the results of experimental research on the properties of electrons have accumulated with startling rapidity. As knowledge grows, the importance of the part played by the electron in the mechanics of the world becomes even clearer. There are all the right signs that progress is being made along a road that really leads somewhere; we are continually finding that, through some electron action, phenomena are linked together between which we had hitherto seen no connection. Precision is given to our views: we find ourselves able to express, quantitatively and with confidence, laws and relations which have been matters of vague surmise. Every experiment that is finished suggests others that are promising. The whole world of experimental physics is full of new life, and of the consciousness that after a period of hesitation the tide of discovery is sweeping on again. While knowledge grows by experiment, theory is also busy. The attempts to co-ordinate the new discoveries are of singular interest because of their daring, their width, and their strength: because they are so often fruitful in prediction: and, not least perhaps, because they seem so often to be irreconcilable with each other.

It helps to a right appreciation of the position as regards the electron if we observe its strong resemblance to the older state of things when first the atomic theory of matter was clearly defined. Just as chemistry has grown and prospered on its recognition of the unit of matter, so electrical science has already begun a new life, and, to all seeming, a most vigorous one, based on the understanding of Nature's unit of electricity. There are many different atoms of matter—nearly a hundred are distinguishable by their different chemical reactions; but the number of different kinds of electrical atoms is very much more limited. We have for some years been clear as to the existence of the electron, Nature's unit of negative electricity. More recently the work of Rutherford and Aston indicates that the nucleus of the hydrogen atom is to be regarded as the positive counterpart.

If the chemist has found so much profit in his recognition of the fact that Nature has just so many ways, and no more, of doing up parcels of matter, the electrician will surely gain in the same way when he grasps the fact that not merely is electricity measurable in quantity, but that there is already a unit of Nature's choice, possibly no more than one unit. We may say with justice that already the most wonderful advances in modern physics are the reward for our appreciation of this truth, and we may hope with equal justice that we are yet far from reaping the full benefit.

The first suggestion of the atomic character of electric charge came, it is well known, from observation of the laws of electrolysis. Since the movement of atoms or atom clusters or ions across the electrolytic cell was accompanied by a simultaneous transfer of electricity, in which each ion, of whatever nature, bore always the same charge or at least a simple multiple of it, there was a clear indication that this division of electricity into parcels of constant magnitude implied the existence of some natural unit charge. No progress, however, was or could be made so long as the charge could be observed only as an attachment to an ion: it was not even clear that it could ever have a separate existence. In the long series of researches which finally led to the isolation of the electron and the determination of its properties, there were certain that marked definite stages in the forward movement. Crookes examined the electric discharge in bulbs exhausted to a high degree by the new air pumps which he had succeeded in making; and he observed the so-called cathode rays streaming away from the negative electrode. He showed that they possessed the properties to be expected from a stream of particles projected across the bulb and carrying negative electricity with them; for on one hand they could heat up bodies on which they fell, and on the other they were deflected in crossing a magnetic field. Crookes spoke of a fourth state of matter and defended his view against the opposing hypothesis, held largely on the Continent, that the stream consisted of electromagnetic waves in some form or other. Hertz showed that the rays could pass through thin sheets of matter such as aluminium leaf, and Lenard took advantage of this to coax them outside the bulb and display their effects in the air outside.

In the later years of last century came the great experiments of Wiechert, Thomson, and many other well-known observers, who weighed the electron and measured its charge, and showed that there was only the one electron, though it was

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

to be found everywhere and in every body. Since then the measurements of these quantities have been repeated many times with increasing skill and understanding. They have reached their present high-water mark perhaps in the experiment of Millikan at Chicago, who gives as the value of the charge in electromagnetic units $e = 1{\cdot}591 \times 10^{-20}$, the mass being $0{\cdot}900 \times 10^{-27}$ gram, or 1/1850 of the mass of the hydrogen atom.

So we arrive finally at an accurate comparison of these unique and fundamental units of Nature with the units which we ourselves have chosen for our convenience, and without, of course, any consideration of the former. We infer from experiments such as those of Kaufmann and of Bucherer that the energy of the moving electron may be considered to exist wholly in the form of electromagnetic energy, such as is necessarily present when an electrical charge is in motion; and that its mass is in this way perfectly accounted for. But this conclusion sets a limit to the size of the electron, and we must assume that its radius, if its form is spherical, is very small compared with the radius of any atom. Also, as the velocity of the electron approaches that of light, its mass increases; imperceptibly at first, but in the end very rapidly.

Why, we may well ask, have these measurements of charge and mass never been made before? The electron is everywhere: the transfer of electricity from place to place consists always in the transfer of electrons. The electric current is a hurrying stream of electrons: all our electrical machinery concerns itself with setting them in motion, with giving them energy and again withdrawing it. In the processes of electrolysis the electrons are handed to and fro. Everywhere they fill the stage; why have we not hitherto noticed their qualities, which so far can be expressed so simply?

The answer is that we have never, until recently, been able to make them move fast enough in spaces sufficiently empty of air or other gases. It is only when an electron has a sufficient speed that it can escape absorption in the atoms which it must be continually meeting. Unless an electron has a speed exceeding about one three-hundredth of the velocity of light—that is to say, such a speed as it acquires in falling through a potential of a few volts—it sticks to the next atom it runs up against: even with ten times that speed it can move only a fraction of a millimetre through air at ordinary pressure before it loses its velocity, and, therefore, its power of going through the atoms. When Crookes first saw the cathode-ray stream in full course, it was because he had reduced the number of gas molecules in his bulb to such an extent that an electron could fly in a straight line from end to end of the bulb without going through more than a hundred atoms or so, and the induction coil had given it quite enough speed to do that without turning out of its course, no matter what sort of atoms they were. Incidentally, since atoms can be traversed in this way, we naturally think of an atom as a very empty affair.

Electrons flying still faster than in the discharge tube are found to constitute a part of the radiation from radioactive substances. Some of the β-rays have velocities nearly equal to that of light and can pass through millions of atoms before their energy is spent. In open air a β-ray may have a course of metres in length, though it is generally broken by encounters with traversed atoms into a path full of corners and irregularities.

It is speed which gives separate existence to the moving electron: and speed which also betrays its presence to us. For, on its way, the electron here and there chips away another electron from an atom which it is crossing and leaves behind it a separation of electricities which may afterwards influence chemical action, as in the case of the phosphorescent screen or photographic plate, or provide a current for the ionisation chamber. We do not know exactly how this removal of electrons is effected, nor why some atoms part with electrons more easily than others, so that the flying electron loses less energy as it goes through: there is much that is obscure in the whole process. But it gives us a ready means of observation, without which, indeed, our knowledge of the electron would be far less than it is.

These electrons which are so made manifest by speed form but a minute fraction of the whole number existing. They are to be found in every body, and in every atom of every body. They form one of the elements of construction of the atom, and it is one of the most immediate aims of present research to find in what way they are built into atomic structure. In every atom there are certain electrons of which one can be removed at the cost of an amount of energy of the order of 10^{-11} ergs. The potential through which an electron must fall so that it acquires this energy is of the order of a few volts. There are other electrons within the atom which are intrinsically far more difficult to remove. On the other hand, some atoms—for example, those of a metal in the solid or liquid condition—have each one or more electrons which are little more than hangers-on, and are, indeed, removed with very little trouble. A block of pure metal is full of such loosely bound electrons, so that if an electric potential difference is maintained across the block an electron flow or electric current is produced. The metal "conducts."

At sufficiently high temperatures all bodies become conductors; we must imagine that the violent thermal agitation shakes electrons free from their ties to the atoms even when at low temperature the bonds ordinarily remain unbroken. At a high temperature, too, the electrons acquire high velocities as they move to and fro with their proper share of heat energy. At the surface of the hot body the electrons may break away; and hence the "thermionic emission" investigated by O. W. Richardson. So copious is this supply of electrons at the surface of a hot body that if the latter is made negative in potential relative to its surroundings there is a current discharge which may sometimes be measurable in amperes. Of course, such a current can pass only one way, negatively from the hot body, or positively towards it. So we get the basic principle of the "valve," and so Coolidge provides the electrons for projection against the target in the X-ray bulb which he has designed. At this point we find already the adaptation of our new knowledge of electrons to apparatus of extraordinarily great use to mankind.

If now we plunge a little deeper into our subject we come to certain most fascinating regions of it, where exploration is still in full progress. In one of these we find the most remarkable connection between moving electrons and electromagnetic waves. One, it seems, can always call up the other, and the action obeys certain precise numerical laws.

Let us take as an example the production of X-rays in a Coolidge bulb. A plentiful supply of electrons is provided at the cathode by heating a fine spiral of tungsten wire to a high temperature. A high potential difference between cathode and target is provided by some approximate means, and the electrons are hurled at the target, each possessing an amount of energy equal to the product of the electron charge and the applied potential. Where the electrons strike, some of their energy is converted into electromagnetic waves of very high frequency, the so-called X-rays. Suppose that we measure the energy supplied to each electron—not an easy matter with the usual arrangements, but very easily done if, as in certain experiments of Duane and Hunt at Harvard University, the potential is derived from a great storage battery of 40,000 volts. Suppose, further, that we analyse by the X-ray spectrometer the X-ray radiation that issues from the target. We find that the frequencies of the emitted rays may have a wide range of values, but that the upper limit of the frequencies is always proportional to the energy of the electron, and, therefore, to the potential imposed on the tube. This ratio remains the same no matter what the intensity of the electron discharge, and no matter what the nature of the target. This ratio of electron energy to maximum frequency is a number which has turned up in previous cases where the emission of radiation energy has been measured: it is known as Planck's constant, and denoted by "h." Its value is $6{\cdot}55 \times 10^{-27}$. Although the constant has been met with before, there is probably no instance where the transformation of energy which it governs is so simply displayed or so easily measured as in the case just described.

In certain measurements made by Duane and Hunt and illustrated in Fig. 1, the X-ray spectrometer was set to observe the presence of a certain frequency as soon as it appeared. The potential on the tube was then increased by degrees. The rays of the given frequency appeared as soon as the energy supplied to the electron was equal to the frequency multiplied by h. As the potential was increased still further these rays increased in intensity, as the figure shows.

It is to be observed that the production of X-rays is no aggregate of individual efforts by separate electrons: each electron produces its own train of X-rays when it strikes the target. There is no sign of any combined action, as, indeed, is evident from the fact that the intensity of the cathode-ray stream is without influence on the frequencies of the X-rays produced.

The crucial point is that when the energy of an electron is handed over in whole or in part, the frequency of the X-ray waves that take over the energy is determined by the quantity of energy handed over. This explains why there is a limit to the frequency of the X-rays: it is because there are some electrons, though only a fraction of the whole number, which give up all their energy to the formation of X-rays at the moment of striking, before they have lost energy in collisions.

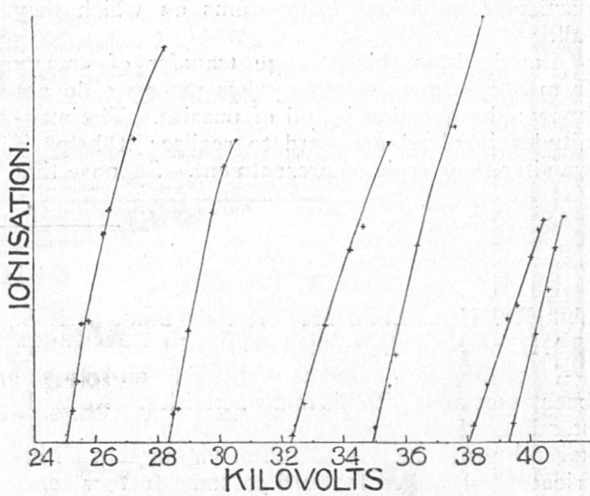


FIG. 1.—From Duane and Hunt, *Physical Review*, 1915, p. 166. Each curve represents the growth in intensity of a certain wave-length as the voltage applied to the X-ray bulb is increased. The wave-lengths are: left to right, 0·488, 0·424, 0·377, 0·345, 0·318, 0·308, all in Ångström units (10^{-8} cm.).

The rest of the rays, all those which have lower frequencies, will come from electrons that have lost speed in this way, or possibly have transferred only part of their energy. The atom of the target is playing the part of a transformer, and does not determine the frequency, so far as these effects are concerned.

All this is wonderful enough; but the marvel is greatly increased by the discovery that the effect is reciprocal. Just as the swiftly moving electrons excite X-rays, so X-rays when they strike any substance lose their energy, which now appears as the energy of moving electrons. And, again, we find the same variation in the result and the same limit to that variation. Among the electrons so set in motion we find, examining them as soon as possible after their motion has begun, every variety of energy-content up to a certain critical value which is equal to the frequency of the X-rays multiplied by the same constant h. It is to be observed that we cannot measure all the electron velocities as soon as they exist because some of the motions begin in the body of the substance, into which the X-rays have penetrated, and have lost speed on the way out. Again, therefore, there is nothing against the hypothesis that the energy of every electron set going by waves of given frequency is originally the same, and is determined by the standard condition already given.

Not only in the case of X-rays are these effects observed, but also in the case of light. The only difference is that the frequencies of light vibrations are some 10,000 times less than those of X-rays, and the electron energies correspondingly smaller. When the light waves produce the electrons we have what is known as the photo-electric effect. The production of light by electrons has been much studied recently in experiments to find "resonance-potentials"—that is to say, the magnitudes of potentials which must act on electrons so as to give them enough energy to excite certain particular radiations from atoms on which they fall.

Exactly how this strange transfer of energy from one form to another takes place we do not know: the question is full of puzzles. The magnitudes involved are hard to realise; it helps if we alter their scale of presentment. Suppose that the target of the X-ray bulb were magnified in size until it was as great as the moon's disc—that is to say, about a hundred million times. The atoms would then be spheres a centimetre or so in diameter. But the electrons would still be invisible to the naked eye. The distance from earth to moon would correspond roughly to the distance that ordinarily separates the bulb from an observer or his apparatus. We now shoot the enlarged electrons at the moon with a certain velocity; let us say that in every second each square yard or square foot or square inch, it does not matter which, receives an electron. A radiation now starts away from the moon which immediately manifests itself (there is no other manifestation whatever) by causing electrons to spring out of bodies on which it falls. They leap out from the earth, here one and there one; from each square mile of sea or land, one a second or thereabouts. They may have various speeds; but none exceed, though some will just reach, the velocity of the original electrons that were fired at the moon. That, reduced again to normal size, is the process that goes on in and about the X-ray bulb: which is part of a universal natural process going on wherever radiation, electron or wave, falls on matter, and which is clearly one of the most important and most fundamental operations in the material world.

(To be continued.)

Obituary.

THE RT. HON. LORD MOULTON OF BANK, F.R.S.

THE news of the sudden death of Lord Moulton on March 9 came as a shock to all who had been associated with his many activities. Notwithstanding his advanced age—he was in his seventy-seventh year—he was so full of vigour that all his friends had looked forward to some further years of activity for the good of the country he loved so well, and for which he rendered such magnificent services. He died in the midst of his work; the very day before his death he was engaged in hearing an appeal at the House of Lords. A short time before, he delivered a speech on behalf of the chemical industries of the country with all his customary lucidity and vigour, and again on February 19 he showed his delightful personal charm as chairman of a "Saturday Evening" at the Savage Club. These random incidents might almost be taken as typical of the outstanding qualities of the man—the brilliant judge and lawyer, the man of science and patriot, and the genial companion whose sympathy and humour helped to brighten many a life, and never more than in the dark days of the war, when he was always ready to cheer and inspire those around him and to lead the way in meeting one difficulty after another.

After his brilliant career previous to the war, in which he had shown himself an adept at science, classics, law, and politics, as well as an athlete and a linguist, Lord Moulton might well have been content to rest upon his laurels, but unquestionably his greatest achievements were for the cause of his country, when, at the age of seventy, he took up a burden which would have taxed the endurance of the strongest man, and set himself to organise the resources of the country to obtain the explosives necessary for the war. Looking back upon his earlier career, it might almost seem that his numerous activities were directed by destiny towards the great climax of his life. Certainly they formed a unique training which fitted him for his supreme task in a way which could scarcely have been paralleled.

Lord Moulton was born on November 18, 1844, at Madeley, his father being the Rev. James Egan Moulton, a Wesleyan minister. After passing through the Wesleyan school at New Kingswood, near Bath, he entered St. John's College, Cambridge, and had a brilliant career as a student. In 1868 he became Senior Wrangler and first Smith's prizeman, and took a gold medal at London University. He was elected a fellow and lecturer at Christ's. His academic career was not of long duration. In 1874, at the age of about thirty, he was called to the Bar, and speedily became famous as a specialist in patent cases. His scientific training gave him a great advantage in dealing with such subjects, and he was entrusted with many cases involving very large issues. In his later years it was a delight of his to recall the patent cases on which he had been engaged, and he was able with his wonderful memory to relate the circumstances in close detail. The esteem in which he was held as a scientific investigator was signalised by his election during this time as a fellow of the Royal Society. One of his greatest efforts at the Bar was as counsel for the newly formed Metropolitan Water Board before the Commission on the water supply of London, and in this his mathematical knowledge was of great service to him in dealing with an intricate set of statistics.

Lord Moulton's Parliamentary career commenced in 1885, when he became M.P. for Clapham. Afterwards he contested other seats, ultimately becoming member for Launceston. He was, however, too independent in thought to attune himself readily to party politics. In 1906 he became a Lord Justice of Appeal, and in 1912 a Lord of Appeal and a member of the Judicial Committee of the Privy Council. He was also made a life peer. At the same time, he had numerous other activities in connection with medical research, engineering, etc.

Then came, in 1914, the great struggle which was to give scope for all his wide experience and wonderful energy. Few men had the vision in those early days of the war to foresee its magnitude as Lord Moulton did. For him there could be no peace of mind when he knew that other men were thinking in tons of explosives while he was already thinking in hundreds of tons. He knew the Germans, knew how they had for a generation specialised in organic chemical industry, and knew also that unless this country made a great and immediate effort, the war would end through shortage of supplies on the side of the Allies. Fortunately, he had a power of insistence which enabled him to impose his influence against all resistance and in spite of all difficulties. In November, 1914, he became chairman of a small Advisory Committee on Chemical Products. Two months later, in consequence of his efforts, the Committee on High Explosives ("A 6") was formed under the War Office, and ultimately he became Director-General of the Department of Explosives Supply under the Ministry of Munitions, and obtained a freedom of action which enabled him to make provision for the abundant supplies of explosives which he foresaw to be necessary.

Lord Moulton gathered round him a staff in which he placed entire confidence. The fear of a shortage was always before him, but he laid his plans with courage and prevision. At the beginning of the war picric acid was the standard high explosive. Lord Moulton realised at once that the supply of raw materials was absolutely inadequate. This necessitated the establishment of a new industry—the synthetic phenol industry—to increase the supply of picric acid, and at the same time the manufacture of T.N.T., which was new to this country, had to be inaugurated. As the demands increased, the T.N.T. had to be economised by mixing it with ammonium nitrate, and this was ultimately done without loss of efficiency. It was characteristic of him that he was untiring in his personal inspection of the explosives factories, and travelled thousands of miles, often at night, to spend Saturdays and Sundays in this way. From end to end of the country his visits were welcomed on account of his helpfulness and encouragement. He and his devoted staff had ultimately the satisfaction of seeing the supplies of explosives increase to such an extent that not only our own needs, but also those of our Allies, were met.

Later in the war the supply of poison gases also came into Lord Moulton's hands. This side of the work was most repugnant to him, but he met it, as a hateful necessity, with his full vigour and with notable success.

By reason of its very efficiency the work was but little heard of, and consequently imperfectly appreciated by the general public. It is pleasant, however, to recall that his efforts were recognised by the conferment of the K.C.B. in 1915 and of the G.B.E. in 1917. He had a host of foreign distinctions, and was a Commander of the Legion of Honour.

After the war Lord Moulton was untiring in his efforts to place the scientific industries of the country on a sound basis. Few, if any, can realise what the country owes to him for his work of the last six years. His self-sacrificing devotion was unbounded. He was a great patriot and a true friend.

R. C. FARMER.

BARON T. KIKUCHI.

MEN of science in this country and in Japan will hear with much regret of the premature death, on March 2, of Baron T. Kikuchi at the age of twenty-seven. The son of a distinguished father, the late Baron Kikuchi, at one time Minister of Education in Japan, he had a distinguished career in the University of Tokyo, specialising in physics under the direction of Prof. Nagaoka. In 1919 he came to England to work in the Cavendish Laboratory under the direction of Sir Ernest Rutherford. His first paper, published in 1920 in the Proceedings of the Royal Society in conjunction with Dr. F. Aston, contained a careful and able examination of the nature and velocity of the swiftly moving striations observed in neon and helium. An account of further independent work on this subject is in course of publication. In the midst of the preparations for the experimental attack on an important physical problem Baron Kikuchi was taken ill and died after a two months' illness in a nursing home in Cambridge. During his illness he was devotedly attended by his young wife, who had come from Japan to join him a few months before. Like his father before him a member of St. John's College, a special memorial service was conducted in the college chapel by the Master, attended by the Vice-Chancellor of the University. The remains were taken to London for cremation.

A man of marked intellectual energy and experimental ability, Baron Kikuchi had been selected to fill an important post in the new National Physical Laboratory at Tokyo on his return from Europe. His intelligence and charm of manner had gained him many friends both in this country and Japan, who deplore the untimely end of such a young life so full of promise of achievement in science. E. R.

THE death of GEORGES HUMBERT on January 22 has removed a mathematician of exceptional powers. Humbert may be compared with Clebsch, because, although he may not have invented a new mathematical engine, he showed unexpected uses of those already provided. In his hands Abel's theorem and Poincaré's researches on Fuchsian functions became magic keys to unlock the treasures of geometry, and give us concrete and elegant images of analytical ideas. One of his most characteristic works is his memoir on hyper-elliptic surfaces, for which he obtained the Bordin prize, and which was published in *Liouville's Journal*. In his later years he was attracted by the theory of numbers, and published several papers on arithmetical forms. Humbert gave lectures at the Ecole Polytechnique, and also at the Collège de France. M.

Notes.

DR. H. K. ANDERSON, Master of Gonville and Caius College, Cambridge; Prof. W. M. Bayliss, professor of general physiology, University College, London; and Sir William H. Bragg, Quain professor of physics, University of London, have been elected members of the Athenæum Club under the provisions of the rule of the club which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public service."

ON Monday last, March 14, the Albert medal of the Royal Society of Arts was presented to Prof. Albert Michelson, foreign member of the Royal Society, for his discovery of a natural constant which has provided a basis for a standard of length. The award was made last year, but the actual presentation was deferred until Prof. Michelson could come to England to receive it. In the absence of H.R.H. the Duke of Connaught, the president, the medal was presented by Mr. Alan Campbell Swinton, the chairman of the council of the society. By the use of his interferometer Prof. Michelson found the length of the Paris standard metre to be 1,553,164 times the wave-length of the red line of cadmium, and his calculations have since been verified as accurate within a limit of error of one wave-length, or say two-millionths of a millimetre. To the society the award is of especial interest, because in 1774 it offered a prize for an invariable standard of length, and up to the present date there has never been found a successful competitor. As the Albert medal is limited to practical applications of science, the society could not recognise any other of Prof. Michelson's scientific discoveries, but its council was doubtless influenced by an appreciation of their extent and value. His construction of optical gratings, determination of the velocity of light, and precise experiments on the relative motion of æther and matter are of fundamental importance, and his échelon spectroscope has provided physicists and astronomers with a most valuable instrument of high resolving power. Several years ago Prof. Michelson used his interferometer to measure the diameters of the four chief satellites of Jupiter, and suggested its application to the fixed stars. This has now been done at the Mount Wilson Observatory, and a short account of the remarkable results obtained was given in NATURE of January 20, p. 676.

THE magnetic research steamer *Carnegie*, of the Carnegie Institution of Washington, returned to San Francisco on February 22 after a scientific expedition to the Indian Ocean, West Australia, New Zealand, Tahiti, and Fanning Islands to investigate the magnetic condition of the earth over ocean areas. The only information as to the results of the voyage yet announced is that the Royal Company Island was sought for in vain. The Royal Company Island or Islands figured on charts of the Southern Ocean for more than a century, having been reported by the Spanish ship *Rafaelo* about 1776 in 49° S., 142° E. Bellingshausen in the Russian Antarctic Expedition appointed the island as a rendezvous for his two ships in January, 1820, but both vessels sought it in vain. Dumont D'Urville on the French Antarctic Expedition in 1840 also searched for the island, but could not find it; still, the name remained on the charts in various positions between 49° and 53° 30′ S. and between 141° and 145° E. The re-discovery of Bouvet Island by the *Valdivia* in 1898, after Cook in 1772 and 1775 and Moore in 1845 had passed within twenty miles without sighting it in their searches, re-awakened doubts as to the non-existence of other islands reported in the Southern Ocean and never seen again. Capt. J. K. Davis in the *Nimrod* of Shackleton's expedition in 1909, and again in the *Aurora* of Mawson's expedition in 1912, sailed over most of the assigned positions and got soundings of more than 2000 fathoms in the vicinity. The work of the *Carnegie* should be held to have completed the difficult task of proving a negative, and so to clear the chart of another iceberg.

THE *Daily Mail* of Saturday last, March 12, publishes a message from its Paris correspondent referring to a prediction by the Abbé Moreux that the next fourteen years will be relatively dry in Western Europe. The alternation of wet and dry periods of about seventeen years each referred to in the report, and in the short leading article upon it, is, however, by no means a new discovery. Indeed, a cycle of precisely the same length and type as that now announced was mentioned more than three hundred years ago by Francis Bacon, and in our own time Prof. E. Brückner, of Berne, has traced its effects in a variety of meteorological phenomena. The Abbé Moreux may have found a new weather-period, but what is described by the *Daily Mail* is nothing more than Brückner's cycle, which corresponds approximately to the length of three sun-spot periods.

THE Report of the Museum Committee of the Borough of Warrington deals with the four years ending June 30, 1920. In May, 1920, Mr. Charles Madeley, who had been director and librarian for forty-four years, died, and the opportunity was taken to separate the museum from the library and to provide each institution with an independent staff. This undoubtedly is a move in the right direction. The new keeper of the museum is Mr. G. A. Dunlop. The collections have received a number of accessions, among which those of local interest are predominant, and include many specimens collected and determined by the Lancashire and Cheshire Fauna Committee, notably 290 Diptera and 77 Hymenoptera obtained by Col. Fairclough in his own garden.

IN spite of difficulties connected with the delayed progress of the new building and the large amount of work entailed by the visit of the British Association, the thirteenth annual report of the National Museum of Wales records considerable progress in all departments. In the natural sciences and in archæology the museum is becoming, as it ought, the headquarters of investigation in the Principality. Thus Dr. Ethel Thomas, keeper of botany, has set going a primary vegetation survey of Wales in co-operation with field-clubs and school-teachers. Dr. Simpson, keeper of zoology, has started a faunistic survey of Glamorgan in conjunction with the Cardiff Naturalists' Society—an effort that is obviously capable of extension. The archæologists of Wales assembled in congress have expressed the opinion that all finds should be preserved in museums for the control and maintenance of which effective provision has been made, and that local museums should be affiliated to the National Museum.

THE Museum Journal of the University of Pennsylvania for September, 1920, contains a well-illustrated article by Dr. W. C. Farabee on several collections of ancient American gold objects that have lately come into the possession of the museum. These objects are of extraordinary interest in the development of art, and many of them are of great beauty. A number of Sumerian tablets, some of which were described by Dr. Stephen Langdon in 1917 as part of a law code, are here translated for the first time by Père V. Scheil, of Paris, and prove the existence of a code at least 1000 years before the famous code of Hammurabi (*circa* 2000 B.C.). Other articles deal with the gold treasure in the Temple of Baal at Nippur (1300 B.C.) and with ancient Peruvian textiles. The latter is illustrated by coloured plates. We may envy our American friends these treasures of art and learning, but a museum that makes its riches so promptly known in this interesting manner deserves to possess them.

THE study of soils as pursued in agricultural institutes deserves far more attention from geologists than it ordinarily receives. W. G. Ogg and J. Hendrick have made interesting experiments ("Studies of a Scottish Drift Soil," *Journ. of Agric. Sci.*, vol. x., p. 55) on the absorptive power for ammonia of powdered granite. The considerable result obtained is not dependent on the presence of weathered material, nor does the amount taken up increase as rapidly as the increase of surface due to finer powdering of the sample. When afterwards treated with water, the powdered granite behaves like a soil, since a part of the ammonia remains fixed, probably by adsorption, on the particles of the rock.

THE Norfolk and Norwich Naturalists' Society has recently published a new number of its Transactions (vol. xi., part 1). The issue includes Mr. J. H. Gurney's presidential address, Prof. Boswell's long and authoritative study of the surface and dip of the chalk in Norfolk, and the report of the Blakeney Point Committee. This report is excellent reading; for Blakeney Point throughout the war had its work of national defence, and good stories are told of quiet English men of science mistaken for spies, and of treasure-trove of wreckage washed ashore. Now the "military authorities" are gone, and the men of science are come back to the Point; as it is said by a writer of admirable prose but shockingly bad poetry: *Cedant arma togae: concedat laurea laudi.* We wish all success to this famous and hard-working society in this fifty-second year of its life; and to Dr. Sidney Long, who has done so much for its welfare.

IN a recent paper (*Journal of Genetics*, vol. x., No. 4) Prof. Punnett and the late Major P. G. Bailey publish some results on the inheritance of egg-colour and broodiness in poultry. The crosses were chiefly between Black Langshans on one hand and Brown Leghorns or Hamburghs on the other. Both broodiness and egg-colour were transmitted by the cock as well as by the hen. Although there is evidence of association between these two characters in inheritance, yet it is found to be possible to establish a non-broody race laying brown eggs. As regards egg-colour, F_1 birds laid eggs of an intermediate tint, and in F_2 there was segregation, with a series of intermediate tints as well as the pure white and dark brown grades. In the reciprocal crosses between Brown Leghorn and Langshan a great difference was found in the eggs laid by F_2 offspring, a preponderance of eggs approaching the colour of the eggs of the female parent in both cases. It is considered, however, that this may have been a coincidence owing to a difference in the composition of the Leghorn strain employed in the two crosses. Broodiness is found to be highly complex, birds sometimes showing the character in one year and not in another, F_1 hens from a cross being usually broody, while in F_2 the proportion of broody to non-broody birds shows great variation in different crosses, and the condition may be due to the action of more than one genetic factor.

ARTICLES V.–VII. in vol. xlii. of the Proceedings of the U.S. National Museum are by Mr. A. C. Kinsey, who writes on the American Cynipidæ or gall-wasps. These contributions are particularly welcome, as students of the family have been few, and there are still large areas of the world from which practically no collections have yet been made. The biological phenomena concerning these insects are of great interest, especially those bearing upon gall-production, parthenogenesis, and alternation of generations. In article v. the author adds sixteen species to those already known, and eight plates are devoted to portraying the particular types of galls produced by them. Article vi. is devoted to a summary of our knowledge of the life-histories of gall-wasps, together with notes on those of a number of American species. We hope the author will see his way at a future date to study their larvæ and the development of the galls in which the latter live. In article vii. are many interesting observations on the phylogeny and general biology of the family. The author tells us that 86 per cent. of the known species of gall-wasps affect Quercus, and are confined to that genus. Another 7 per cent. are confined to species of Rosa. The remaining 7 per cent. are found in plants belonging to various natural orders, and it is evident therefrom that 93 per cent. of the known Cynipidæ are restricted to two genera of plants only. Among other features a table is given of the proportions of the sexes which obtain in the various species. In some cases males are unknown, and in others the proportion of this sex to females varies from 1·5 per cent. in *Rhodites rosae* to 55 per cent. in *Aulacidea podagrae*. The author concludes that alternation of generations is a more or less extreme type of seasonal dimorphism, and is primarily due to seasonal environmental conditions.

ACCORDING to the annual report on the Forest Administration of Nigeria for 1919, out of a total estimated forest area of 218,000 square miles only 3143 square miles have so far been permanently reserved as forest, though an additional area of 2558 square miles is in process of reservation; this will bring the area of reserved forests to 2·6 per cent. of the total estimated forest area and less than 1·7 per cent. of the total area of Nigeria. The Director of Forests urges with good reason the necessity for more rapid progress in the reservation of forests up to at least 25 per cent. of the total area of the country, the urgency being the greater from the fact that the forests are otherwise threatened with destruction by shifting cultivation. Scientific forest management is still in its infancy. There are no working plans, and meanwhile the forests are worked under a crude form of selection fellings regulated by a minimum-girth limit, this being the only method of treatment possible with the present small staff. Artificial regeneration has made some slight progress, and the Director of Forests is alive to the possibility, under suitable conditions, of raising plantations with the aid of shifting cultivation—a system found so successful in Burma. The chief timbers extracted are described as mahoganies and cedars, together with *Terminalia superba, Mitragyna macrophylla, Scottelia kamerunensis, Lophira procera,* and *Uapaca Staudtii*. Exports consisted almost entirely of mahogany, to the extent of 8516 logs valued at 115,820*l.*

A MEMOIR on "North-Western Queensland," issued as Publication 265 by the Queensland Geological Survey (1920), describes a region of metamorphosed sediments, possibly Silurian, unconformably overlain by Jurassic strata with artesian water, and including important mines of copper and iron. A feature of the memoir is the use of colour in the geological sections, which adds very agreeably to their clearness, as Portlock and the earlier geologists realised in the palmy days of publication.

NOW that the question of the relation of kame-mounds and eskers to ice-margins has been once more raised in the British Isles, attention may be directed to the study of the Newington Moraine of New England, extending across Maine, New Hampshire, and Massachusetts, by F. J. Katz and A. Keith (U.S. Geol. Surv., Prof. Paper 108–B). The gravels are sometimes bouldery and unsorted, sometimes well stratified, and the long ridge represents material graduating south-eastward into an outwash-plain of clay and deposited from an ice-front in the sea. Leda-clay sometimes overlaps the moraine material.

IT is to be hoped that the new Egyptian Government will continue the series of informing publications now issued by the Geological Survey of Egypt under the Ministry of Finance. In Palæontological Series No. 4 M. R. Fourtau describes the Neogene Echinoderms, and is able to assure us that, thanks to collections made by Messrs. Madgwick and Moon and Hassan Effendi Saddek during the recent exploration of the petroliferous zone, this echinodermal fauna is now completely represented in the Cairo Museum. While the genera as a whole are of Mediterranean types, interesting additions occur which have hitherto been regarded as exclusively Indo-Australian. In the lithographed plates, executed in Paris, the large flattened or domed genera so characteristic of Miocene times are handsomely represented.

THE report of the proceedings of the fourth International Meteorological Conference held in Paris from September 30 to October 6, 1919, has been rendered into English by the Meteorological Office, and is now published by the Air Ministry as Paper M.O. 239. As the last International Conference met so long ago as 1905, there was a wealth of new material to discuss. The meeting dealt with international meteorological organisation in all its branches; the present position of the science with regard to aviation, artillery, transport, and the physics of the air was reviewed, and codes for the transmission of observations on climatology and aerology were discussed. A number of commissions were deputed to report on the preparation of an international meteorological vocabulary and to supervise scientific investigations. Included in the report are nine appendices giving the minutes of meetings of the commissions appointed at the conference, a list of the sources from which the Meteorological Office in London has received data during the past ten years, and a note by M. Bjerknes on the projection and scale of charts.

THE January issue of the Proceedings of the Cambridge Philosophical Society contains a summary by Dr. E. H. Hankin of the papers on flight which he has contributed to the *Aeronautical Journal* during the past ten years. Dr. Hankin has been able to study under exceptionally good conditions during his residence in India the circumstances which influence the soaring flight of birds, dragon-flies, and flying-fishes. In all cases the wings of the bird, dragon-fly, or fish are more nearly horizontal the faster the flight, and the speeds attained are very similar, *i.e.* from 5 to 10 metres per second for slow, and between 15 and 20 for fast, flight, whether of vulture, dragon-fly, or flying-fish. The regularity of the soaring flight of cranes in flocks disproves the theory which attributes it to chance air-currents. Both dragon-flies and flying-fish use their wings, legs, or abdomen as brakes during soaring flight, and this use discredits the theory that the flight is due to imperceptible wing movements, which, if they existed, the bird or fish could diminish at will. The horizontality of the wings disproves the side-current theory, while observations of soaring in the midst of aerial seeds or feathers which showed no irregularity of motion render the theory of turbulence untenable. Dr. Hankin thinks that direct observation requires to be supplemented by experiment before a satisfactory explanation of soaring flight can be furnished.

THE Collected Researches of the National Physical Laboratory (vol. xv.) is a reprint of eighteen papers dealing with physical, metallurgical, and engineering subjects which have appeared in the proceedings of scientific societies or in the technical Press during the years 1915–19. So many of these papers are of great value that it is difficult to select any one for special comment, but five by Dr. N. Campbell alone or in collaboration with Mr. C. C. Patterson illustrate so well the character of the scientific and industrial problems which the laboratory is called upon to solve that their nature may be indicated. They deal first with the present theory of the high-potential magneto, and show that it does not yet furnish a sufficiently firm basis on which to attempt improvements of the machine. They then consider the nature of the spark at the break in the primary of such a machine, and establish the fact that it is in reality an arc. Lastly, they deal with the effect of the spark discharge in igniting explosive mixtures such as those used in gas- and oil-engines, and show that the energy necessary to initiate an explosion is much less than that supplied in practice at the present time. At several points of the papers it is intimated that the research has been discontinued, and if this is the case it seems unfortunate for the gas-engine industry.

To facilitate the systematic testing of samples of dust from coal-mines made necessary by the Act of 1920, Messrs. A. Gallenkamp and Co. are supplying sets of apparatus (according to the designs of Mr. S. R. Illingworth, of the School of Mines, Treforest) which seem very well adapted for the purpose. The drying is effected in an oven, similar to that used by the U.S. Bureau of Mines, through which dry air is drawn so as to change completely the atmosphere round the samples every six minutes, the outer jacket containing water with 5 per cent. of glycerine. The roasting dishes are of silica with aluminium lids, and they are inserted at one end of an electric muffle furnace so wound that the temperature gradually increases from front to back to prevent the coking of the freshly introduced samples. The burnt samples are withdrawn from a door at the back after they have stood for some time at the full temperature of 800–850° C. The roasting dishes stand on silica slabs, by which they are pushed in and withdrawn from the furnace. A scheme of weighing and heating two batches of samples alternately is suggested whereby twenty-four samples might be analysed by one chemist in a working day; if the apparatus enables this to be done—and the suggestion appears to be feasible—it will certainly be an improvement on present practice. The scheme of tests does not include the determination of carbon dioxide in "carbonate" dusts. These dusts are coming into use, and a small addition to the apparatus for this purpose might be desirable.

MR. R. D. DUNCAN, of the Radio Engineer Signal Corps of the U.S. Army, contributes a valuable paper on "wired radio" to the Journal of the Franklin Institute for January. By "wired radio" is meant simply the use of high-frequency currents superposed on ordinary telephone or telegraph lines to transmit speech or signals without interfering with the normal working of the line. One of the reasons for originating this research in America was an attempt to utilise the large quantity of radio-telephone apparatus which had been purchased during the war. One advantage of this system is that speech distortion, which causes so much trouble in long-distance wire telephony, is practically eliminated. The attenuation also is much less than had been anticipated. A very interesting and important application of the method is for establishing communication with a train in motion. Experiments carried out on the New York Central Railway are described. The telephone conductors which run parallel to the railway track were used to carry the high-frequency currents, and at the fixed station the transmitting and receiving apparatus were connected between the aerial wire and the earth. In the moving train the apparatus was connected to a closed loop which was placed at the proper angle to the plane of the telephone wires. Employing this system and using a high-frequency power of only two watts, excellent telephony was obtained up to a distance of ninety miles. It was noticed that the signals received in the train varied periodically in intensity when it was in motion. This phenomenon was traced to the existence of "standing waves" on the telephone line.

Engineering for February 18 contains a communication from the Metropolitan-Vickers Electrical Co., Ltd., which gives an explanation of the causes leading to the breakdown of a new 15,000-kw. turbo-alternator at Dalmarnock Station, Glasgow. The insulation on the windings at one end of the machine took fire on December 8, and the whole insulation on this end was destroyed. Another generator was nearly ready, and was installed and set to work one week later. After running for a week sparks were seen issuing from the top of the stator frame, and the machine was shut down. Examination showed that one of the insulated bolts through the core had broken down near the end plate. These bolts pass through the core in an axial direction and serve to hold the end plates tightly against the laminations. Inspection of the bolts showed that vibration of a more or less serious nature had occurred on several of them. A series of tests revealed the fact that for the particular length and diameter of bolt used a relatively slight tension was sufficient to bring the frequency of the bolts to such a value as to synchronise with the frequency of the whole set, corresponding to the speed of 1500 r.p.m. Re-inspection of the first machine indicated that breakdown was due to the same trouble. A third machine with bolts of a modified design has been running since the end of December and has carried peak loads of 21,000 kw. The new type of bolt has a natural frequency very far below the running frequency of the machine.

IN the notice of a volume on "The Control of Parenthood" which appeared in NATURE for March 3 (pp. 5–6), the reviewer remarked that "Dr. Mary Scharlieb, the doctor of medicine, differs in emphatic terms from Dr. Marie Stopes, the doctor of science and philosophy." Dr. Stopes has written to express the opinion that these words will give readers the impression that Dr. Mary Scharlieb's "antagonism to birth-control methods is based on medically determined detrimental effects of specified methods," whereas she holds that "under cover of the title of doctor of medicine Dr. Mary Scharlieb voices a religious conviction." We would prefer not to devote space to the difference between these points of view, but among the passages upon which our reviewer founded his statement is one on pp. 105–6 of the book noticed, and we refer Dr. Stopes to this in justification of his remark. But surely she is hasty in thinking that readers of NATURE will read into the meaning of the sentence solely the medical aspects of the subject (which she claims were not decided by the evidence before the Commission). Is it not much more likely that some readers will, as is their wont, see less and some more than the words justify, whilst others will see simply the literal meaning?

STUDENTS of India and the Far East should be interested in the latest catalogue (No. 411) of Mr. F. Edwards, 83 High Street, Marylebone, W.1, which gives particulars of some 1133 books, engravings, and drawings relating to India, Afghanistan, Ceylon, Burma, Tibet, Central Asia, Persia, etc. The catalogue will be sent free by the publisher upon request.

Our Astronomical Column.

THE FIREBALL OF MARCH 2.—Mr. W. F. Denning writes that further observations of this meteor have been received from Mr. Thomas Dick, of Purley, Surrey, Mr. G. Merton, of Woldingham, Surrey, and an observer in Hertfordshire. Mr. Merton did not observe the fireball in flight, but noticed the illumination it caused. He was about to observe a star in his telescope when the whole inside of the observatory was lit up for a few seconds, and he rightly concluded that a large meteor had fallen. From a comparison of all the observations it appears that the radiant point was at about $176°+24°$, and that the height of the meteor declined from 77 to 34 miles along a path of 61 miles, traversed at a velocity of 20 miles per second. Further observations of an exact character of the apparent course of the meteor amongst the stars would be valuable. It is to be hoped that in future years special attention will be given by meteoric observers to the first few nights of March, for past experiences amply testify to a special abundance of fireballs at this period.

THE ROTATION OF VENUS.—The problem of the rotation period of our nearest planetary neighbour has proved to be one of the most baffling of astronomical enigmas. Before Schiaparelli's announcement that it always turned one face to the sun, its period was supposed to differ little from that of the earth. Since then astronomers have been fairly equally divided between supporters of the short and of the long period.

In the last few weeks Prof. W. H. Pickering, who has been observing the planet in the clear and steady air of Mandeville, Jamaica, has put forward a new solution. He claims to have fixed the period as sixty-eight hours, the axis of rotation lying very nearly in the plane of the orbit, with which it makes an angle of only 4° or 5°. Such a bizarre arrangement does not strike one as probable *a priori*, in view of the considerable tides which the sun raises on the planet. It prevails in the Uranian system, but the solar tides there are much feebler, since, *ceteris paribus*, they vary as the inverse cube of the distance from the tide-raising body. However, when Prof. Pickering's full evidence for his new period arrives it will be carefully studied, and will doubtless stimulate other observers to use their best endeavours to verify it.

A SIMPLIFIED CALENDAR REFORM.—In view of the difficulty of obtaining agreement on the vexed subject of calendar reform, the Rev. Emilio Fanfani, of Pavia, has published a pamphlet in which he reduces the proposed change to a minimum. His suggestion is to leave the lengths of the months the same as at present, but to put January 1, and in leap year February 29 also, outside the weekly reckoning, calling them simply New Year's Day and Leap Day. Thus the week-days would recur annually on the same calendar dates. The author further recommends that the present year 1921 should be taken as the standard, since Christmas occurs on a Sunday. Thus January 1, 1922, would be New Year's Day and January 2 Sunday, as in 1921. He further recommends the fixing of Easter on April 10, though this is not an essential part of his scheme.

This plan has the recommendation that the calculated dates of future astronomical events are unaffected, and no alteration of astronomical tables is involved. While it does not do all that calendar reformers desire, it is at least better than nothing, and would be a boon in fixing school terms, commercial transactions, the meeting of societies, etc.

Prof. Pio Emanuelli, of the Vatican Observatory, contributes a preface, in which he commends the project to the Commission on Calendar Reform constituted by the International Astronomical Union.

The Inheritance of Acquired Characters.

FOR a generation it has been a cardinal principle of thought and teaching with a majority of biologists that acquired characters are not inherited. Under the influence of Weismann and his doctrine of the independence of germ and soma this position has frequently been adopted even in its extreme form, that the inheritance of acquired characters is an impossibility. Botanists, on the other hand, have usually been less dogmatic on the subject, probably because in higher plants there is no such early segregation of germ-cells and somatic cells as occurs in many animals.

But in recent years new experiments have exhibited the problem in fresh lights, and the tendency to dogmatism which had grown up around the subject is fast disappearing. Prof. E. W. MacBride, in a trenchant article (*Science Progress*, January) which will mark a new stage in the discussion of this problem, subjects various aspects of Weismannism to a searching criticism, and shows how arguments which seemed so triumphantly unanswerable in Weismann's time are no longer in accord with the modern facts of experimental biology.

Perhaps the most fundamental of the defects of Weismannism as a philosophy of the organism was its foundation upon purely morphological conceptions of heredity, variation, and organic structure. While we shall always be indebted to him for the emphasis which he laid upon the chromosomes as a basis of heredity, yet a considerable part of the superstructure which he built on that foundation is no longer in accord with modern experiment. As Prof. MacBride points out, Weismann's view that the differentiation during ontogeny is the result of differential divisions of the chromosomes in mitosis is contrary to the evidence of both experimental embryology and cytology. Rather, the conclusion seems clear that all the nuclei of an organism are equipotential, the splitting of the chromosomes being, as it appears under the microscope, an equal one. If that is the case, then the nuclei may be looked upon as the conservative repositories of many at least of the differences which arise between species, while the mass divisions of the cytoplasm account for the greater part of the differentiation which takes place during development.

Another weakness in Weismannism which Prof. MacBride points out is the assumption that although the germ-cells of an organism might be affected by climate, they could not be modified by the fluids from the body-tissues in which they were immersed. The physiologists, by means of hormones, enzymes, antibodies, cytolysins, etc., have helped to rescue us from the untenable position that the germ-cells are completely insulated within the organism, and the work of various investigators has led us to see that germinal changes can be experimentally produced.

This does not, however, necessarily involve the principle of the inheritance of acquired characters, but it does render it reasonable to suppose that such inheritance may take place. The question then reduces itself to one of unprejudiced evidence, and on this point Prof. MacBride refers to the much-discussed investigations of Kammerer, whose results can now be contradicted only by imputing fraud, and to the perhaps even more important, because incontrovertible, evidence recently obtained by Messrs. Guyer and Smith (see article by Prof. Dendy in NATURE for February 3, p. 742) in producing a race of rabbits with defective eyes by the action of a cytolysin on the mother.

It is clear that the Lamarckian principle of use and disuse, as well as the various Neo-Lamarckian subtleties involving the inheritance of acquired characters, will have to be reckoned with seriously in future as an evolutionary factor. There is one point, however, in which we would venture to differ from Prof. MacBride, and that is with regard to the evolutionary significance to be attached to mutations. It is true that many of the mutations studied in plants and animals are more or less pathological or abnormal, and would stand a very poor chance of surviving in equal competition under wild conditions. On the theory of mutations this is to be expected, as well as the occurrence of many lethal factors such as are now known in Drosophila and Œnothera. But viable mutations, or even those which in some circumstances will have an advantage over the parent species, are by no means unknown. Bridges (*Biol. Bull.*, vol. xxxviii., p. 231) has recently described a mutation in Drosophila with white ocelli, which maintained itself in equal numbers in competition with the type in mass-culture for about 175 generations. The character-difference is here insignificant, but in wild species of plants there are innumerable records of single variations which have arisen and perpetuated themselves, having neither an advantage nor a disadvantage in competition with the parent species so far as can be determined.

Mutations are also by no means all *loss* characters. In the Œnotheras a series of forms is now known having a whole extra chromosome in their nuclei; and since the doubling of the whole series of chromosomes (tetraploidy) was investigated in *Œnothera gigas*, a large number of genera of plants have been found to contain tetraploid species, showing that this particular type of mutation is not only in a sense progressive, but has also taken part in the phylogeny of various genera and families.

May we not, then, suppose that mutation and the Lamarckian factor have both played their part in evolution, natural selection frequently coming in to adjudicate between mutations, while the Lamarckian factor has been at work in many cases of adaptation?

R. RUGGLES GATES.

Home-grown Wheat.

THE Ministry of Agriculture has instituted a campaign to secure by educational methods an increase in the wheat production of this country. An account of the addresses delivered in connection with this campaign by the principal of the Harper-Adams Agricultural College appeared in the Ministry's General Service for December 11 last. These addresses dealt with the subject from two points of view: the need for stimulating production and the best methods of raising the average yield.

Though Great Britain obtains its wheat from many parts of the world, and it is scarcely conceivable that a shortage would occur through simultaneous failure of the crops in all these countries, yet it is imperative that our own yield should be increased, since the available figures from other producing countries and the growing demands from nations which are becoming wheat-eaters all point to a reduced supply for Great Britain. That our production can be increased becomes evident from a comparison of the figures for different years, *e.g.* in 1868 16,733,000 quarters of wheat were produced compared with 6,677,000 quarters in 1920.

During the war patriotism was certainly one of the controlling factors in the production of home-grown wheat, but now that conditions are more or less normal price becomes the dominant factor. The Agriculture Act has considerably changed the position of the wheat-grower in this country, and with a free and uncontrolled market, as well as a guarantee against loss in the event of the world's price falling below the cost of production, the growing of wheat becomes an attractive scheme. The guarantee is based on the acreage sown, and not on the quantity of grain per acre, and the four-quarters-per-acre basis for the guarantee should be a stimulus to the light-land farmer to grow wheat, while on heavy land and "wheat-land" there is the stimulus of a higher return on account of the greater yields. Probably the best way to increase production is to raise the average yield per acre throughout the country.

The Harper-Adams Agricultural College has been carrying out tests for some years, and the results show what large differences exist between the yielding powers of different varieties. In a three-year average the "Standard" variety of wheat showed a yield of 33 bushels per acre, while "Svalof Iron" headed the list with 56 bushels per acre, so that it is obvious that by using some of the new higher yielding varieties the yield per acre could be considerably increased. At one time Great Britain boasted that her average wheat yield per acre was higher than that of any other country in the world, but the figures for 1919 show that we are now below other countries, the yield for Denmark being 47·5 bushels per acre against 29·1 bushels per acre in Great Britain.

Judicious manuring is one of the surest aids to increased yield, and even at present prices an increase of three bushels per acre amply repays the application of 1 cwt. of sulphate of ammonia. Other points to be considered are the time and the rate of sowing. All available experiments seem to favour the autumn-sown wheat, while it seems very probable that a big saving could be effected by reducing the amount of seed sown per acre.

Hydrography of the Nile Basin.

THE hydrographical data relating to the Nile and its upper reaches were published last year by the Public Works Ministry of Egypt in a report entitled "Nile Control," which was reviewed in these columns on December 30 last. The information was collected for the use of the Technical Commission which was appointed last year to report upon the various projects prepared by the Ministry for controlling and distributing the Nile waters in Egypt and the Sudan. The report of the Commission has now been published ("Report of the Nile Projects Commission," Cairo, 1920). The Commission consisted of two hydraulic engineers of wide experience, Mr. F. S. J. Gebbie, nominated by the Government of India, and Mr. H. F. Cory, nominated by the Government of the United States; also of Dr. G. C. Simpson, nominated by the University of Cambridge as a physicist whose scientific knowledge and experience were desired in connection with problems in water measurement. Criticism of the projects had been rife for many months, and had culminated in a series of charges being brought against the Ministry of Public Works by Sir W. Willcocks and Col. Kennedy, in which falsification of data and suppression of records were alleged. More than half of the report is taken up by a consideration of these charges by the Commission, which has reported unanimously that there had been no falsification or any fraudulent manipulation of data.

Passing to the consideration of the technical merits of the projects for the dams at Gebel Aulia on the White Nile and at Sennar on the Blue Nile, for the barrage at Nag' Hamadi in Upper Egypt, for a dam on the upper reaches of the Blue Nile and for another on Lake Albert, the Commission reports wholly in favour of each of them. It does not consider that proposals for the construction of reservoirs in the marsh region of the White Nile are worthy of investigation. The further terms of reference, the allocation of the increased supply of available water and the apportionment of cost, produced a minority report from Mr. Cory. On the measurement of river discharges the Commission expresses the opinion that there is no other river in the world for which the discharge is so accurately determined as that of the Nile, and its report bears out what has been fully set out in "Nile Control," that the present-day needs of Egypt and the Sudan demand the highest precision in the control and distribution of the Nile water. The addition of a Physical Department to the Ministry of Public Works indicates that this has been recognised, and it is to be hoped that when a fuller measure of responsibility is placed upon Egyptian administrators they too will realise the necessity for maintaining the highest efficiency in all that concerns the scientific study of the hydrography of the Nile basin.

University and Educational Intelligence.

BIRMINGHAM.—Mr. John G. Garrett has been appointed lecturer and demonstrator in mine surveying, and Mr. John P. Rees lecturer in metal mining.

The following new members of the staff of Queen's Hospital have been appointed University clinical teachers:—Dr. Geoffrey Eden, assistant lecturer on clinical medicine and junior medical tutor, and Mr. W. Gemmill, assistant lecturer on clinical surgery.

EDINBURGH.—The committee organised in 1911 by the late Prof. MacGregor to promote a memorial to Prof. Tait in the form of a second chair of natural philosophy is now in a position to report to the subscribers and others interested that the Tait chair will shortly be established. The funds collected before the war have now been substantially augmented by sums from other sources, and the committee, after conferring with the University Court, has been informed by it that it will be possible to arrange for the foundation of the chair not later than the year 1925, by which time certain funds set aside by the University Court towards the endowment of the chair will have matured. In announcing this gratifying decision the Tait Memorial Committee believes that there are still many of Prof. Tait's former pupils and friends desirous of being associated in the promotion of this lasting memorial to a great natural philosopher. Further and immediate contributions will make it possible to inaugurate the Tait chair of natural philosophy before 1925. Further information may be obtained from the hon. secretary, Dr. C. G. Knott, University of Edinburgh.

GLASGOW.—The Lord Rector is *ex-officio* president of the University Court, and takes the chair at least once during his three years' term of office. On Friday, March 11, Mr. Bonar Law, after his installation in the forenoon, presided at a formal meeting of the Court. The business was of special interest, as testifying to the sympathy and support which the city has for many generations accorded to the University. Securities for 21,050*l*. were received from Sir D. M. Stevenson, Bart., ex-Lord Provost, for the foundation of a Citizenship Trust. The purpose of the Trust is to establish a Stevenson lectureship or chair analogous to the Gifford foundation, "to make provision in Glasgow for instruction in the rights, duties, and obligations of citizens in relation to the city, the State, and the commonwealth of nations; to promote study, inquiry, and research in subjects bearing on local government, national polity, and international comity; and thereby to emphasise the compatibility of civic or local with national patriotism, and of both with full and free international co-operation."

Lord Weir next presented to the Lord Rector a cheque for 30,200*l*. on behalf of the Institution of Engineers and Shipbuilders in Scotland. The sum had been contributed by members and friends of the institution by way of commemorating the centenary of the death of James Watt, formerly mathematical instrument maker to the University, for the purpose of increasing the facilities provided in the James Watt (University) laboratories for the scientific study of engineering. It is proposed to use the fund for the purpose of erecting into James Watt professorships the two lectureships in electrical engineering and in heat engines already established in the department. Lord Weir took the opportunity to announce that the institution had resolved to confer the rare distinction of its honorary membership on Mr. Bonar Law, "formerly iron merchant in Glasgow."

Lastly, it was intimated to the Court that the late Mr. Robert Wylie, chairman of Wylie and Lochhead, Ltd., had bequeathed the residue of his estate for the further endowment of the Regius chair of engineering and of engineering teaching in the James Watt laboratories of the University in commemoration of the benefits conferred on mankind by the labours of James Watt. He had also bequeathed his library of books relating to Glasgow, and all his engravings, etchings, and water-colour drawings. It is understood that the bequest, after the expiry of certain life-rents, will amount to a larger sum than any previous benefaction of the kind.

A large extension of the James Watt laboratories, in which the engineering department of the University is housed, is nearing completion. It has been rendered necessary by the great influx of students after the war. In October, 1920, many applicants had to be denied admission.

DR. F. C. THOMPSON, of the University of Sheffield, has been appointed to the chair of metallurgy in the University of Manchester.

THE PRINCE OF WALES will be present at the London University graduation dinner to be held at the Guildhall on May 5, and, as the recipient of the degrees of Doctor of Science and Master of Commerce, will respond to the toast of "The New Graduates."

ON June 28 the University of Durham will confer the honorary degree of D.Sc. upon Sir E. H. W. Tennyson-d'Eyncourt, director of naval construction at the Admiralty, and Prof. A. Meek, professor of zoology at Armstrong College, Newcastle-upon-Tyne.

NOTICE is given by the Royal Society of Medicine of the award in June next of the William Gibson research scholarship of 250*l*. for two years for a qualified medical woman. Particulars may be obtained from the secretary of the society, 1 Wimpole Street, W.1.

ON Saturday last the University of Dublin conferred the honorary degree of Sc.D. upon Prof. W. M. Bayliss, professor of general physiology in University College, London; Prof. E. Borel, professor of the theory of functions at the Sorbonne, Paris; and Prof. A. A. Michelson, professor of physics in the University of Chicago.

APPLICATIONS are invited for the John Lucas Walker studentship in pathology in the University of Cambridge. The studentship is of the annual value of 300*l*. and tenable, under certain conditions, for three years. Candidates must be prepared to devote themselves to original research in pathology, and must send their applications, with copies of published work and references, before April 5 next to Prof. Sir German Woodhead, Pathological Laboratory, Medical School, Cambridge.

THE annual report of the Delegates for Forestry of the University of Oxford contains a record of the valuable work which has been accomplished at the school during the past year. More than 100 students, of whom 80 were first-year men, have been attending classes, and temporary assistance in the work of instruction was afforded by the loan of four officers, three of them from the Forestry Commission and one from the India Office. Practical work was undertaken in the Forest of Dean, High Meadow Woods, and Tintern Crown Forests, and in September a party of twenty-five students accompanied the professor on a tour through some of the forests of France. The scheme for raising plants for sale in the Bagley Forest Nursery was abandoned during the year on account of the high cost of labour, but the nursery will be maintained for raising plants for local use and for demonstration purposes. During the year thirty-six students qualified for the diploma in forestry, two of whom, we note, are ladies. The delegates also pay eloquent tribute to the work of Sir William Schlich, who has resigned his professorship after a tenure of fifteen years.

IN the annual report of the Commissioner of Education for the United States for the year ending June, 1920, brief summaries of progress in some phases of education in America are given, together with a short statement of the activities of the Bureau of Education. Formerly the annual report was printed in two large volumes, but four years ago it was decided to issue this form of report biennially and to supplement it with a brief annual sketch, such as the one before us of 134 pages. In the section dealing with higher education attention is directed to the large increase in the numbers of students receiving instruction and to the financial embarrassment in which most of the universities and colleges find themselves. A comparison of the total enrolments for the academic year 1916 with those of 1919 show an increase of 25 per cent. at the 250 institutions from which statistics were obtained. Reference is also made to the low salaries which are being paid at public and private institutions for higher education. Another point of interest is the introduction of general intelligence tests such as are used in the American Army as an alternative to entrance examinations, and it is estimated that some 200 colleges and universities are using such psychological tests. Attempts are also being made by co-operation with industrial associations to bring higher educational institutions into closer relations with the needs of the industries of the country.

Calendar of Scientific Pioneers.

March 17, 1771. Chester Moor Hall died.—An Essex landowner and a lawyer, Hall in 1733 was the first to construct an achromatic telescope.

March 17, 1782. Daniel Bernoulli died.—Trained as a mathematician by his brother Nicholas, Daniel Bernoulli added greatly to the fame of the family. Like Euler, his lifelong friend, he received no fewer than ten prizes from the Paris Academy of Sciences. His best-known work was that on hydrodynamics.

March 17, 1846. Friedrich Wilhelm Bessel died.—One of the greatest of astronomers, Bessel was director of the Königsberg Observatory, where he erected the first of Fraunhofer's heliometers. Among his most important labours were the reduction of Bradley's observations, the determination of the parallax of 61 Cygni, his two catalogues of stars, and in pure mathematics the invention of Bessel's functions.

March 17, 1853. Christian Doppler died.—Doppler was a professor of mathematics at Prague. In 1842, in a paper on the coloured light of double stars, he enunçiated the well-known principle which bears his name.

March 18, 1871. Augustus de Morgan died.—The first professor of mathematics in University College, London, de Morgan exercised a great influence by his teaching and writings on mathematics and logic. He was deeply versed in the history of mathematics.

March 18, 1907. Pierre Eugène Marcellin Berthelot died.—Professor of organic chemistry in the Collège de France and secretary to the Paris Academy of Sciences, Berthelot made important researches in thermo-chemistry, explosives, and synthetic chemistry.

March 20, 1727. Sir Isaac Newton died.—Universally recognised as the world's greatest mathematical physicist, Newton was born on Christmas Day, 1642. In 1669 he became Lucasian professor of mathematics at Cambridge, in 1689 was elected Member of Parliament for the University, and in 1699 was made Master of the Mint. From 1703 until his death he was president of the Royal Society. His "Principia" was published in 1687. His grave is in the nave of Westminster Abbey, while his monument—the long inscription on which evoked a protest from Johnson—stands close by. The statue of Newton by Roubillac at Trinity College, Cambridge, bears the words: "Qui genus humanum ingenio superavit."

March 20, 1878. Julius Robert von Mayer died.—One of the founders of the science of thermodynamics, Mayer in 1841 settled at Heilbron as a physician, and his memoir on the mechanical theory of heat was published the following year.

March 21, 1762. Nicolas Louis de Lacaille died.—Lacaille was the first to measure an arc of meridian in South Africa. He published three catalogues of stars, the second of which was based on his work at the Cape of Good Hope in 1750–54.

March 22, 1772. John Canton died.—A private schoolmaster in Spitalfields, Canton was a keen experimentalist. He made improvements in electricity and demonstrated the compressibility of water.

March 23, 1899. Gustav Heinrich Wiedemann died.—The successor in 1877 of Poggendorf as editor of the *Annalen der Physik und Chemie*, Wiedemann was known for his accurate physical determinations and for his monumental work entitled "Die Lehre von der Elektricität." E. C. S.

Societies and Academies.

LONDON.

Linnean Society, February 17.—Dr. A. Smith Woodward, president, in the chair.—Prof. G. B. **De Toni**: A contribution to the teratology of the genus Datura, L. A hitherto unreported malformation of the flower of *D. stramonium*. A plant grown in the Botanical Garden at Modena produced flowers of two kinds; normal flowers appeared on the lower part of the plant and produced perfect capsules, but flowers produced in the upper part of the plant later in the year were barren.—Capt. J. **Ramsbottom**: The collection of plants made by various members of H.M. Salonika Forces. A plant-collecting competition amongst warrant officers, non-commissioned officers, and men was held. The result of the competition was satisfactory, as it also had the effect of centralising effort and attracting a considerable number of other collectors. The district in which the principal collectors were stationed was indicated on a map.—Dr. G. C. **Druce**: A short account of botanical work in the Shetlands. A Plantago from the north of Balta Sound, which may be compared to *P. maritima*, var. *minor*, Hook., renamed by Boswell Syme var. *hirsuta*, was discussed. *Cerastium subtetrandrum*, Murb., *Potamogeton suecicus*, C. Richt., *P. rutilus*, Wolfg., *Rhinanthus borealis*, Druce, and *Poa irrigata*, Lindm., are described as new to the flora. *Nitella nidifica*, Ag., found in the Loch of Stenness, and *Chara canescens*, H. and J. Groves, are new to the Scottish flora.

Geological Society, February 18.—Mr. R. D. Oldham, president, in the chair.—R. D. **Oldham**: Presidential address: Know your faults. The address was devoted to a consideration of the dangers of a loose use of words. The first instance taken was that of the common classification of faults as normal and reversed. It became generally accepted that normal faults in the technical sense were normal in the dictionary sense, though this is not always in accord with experience. Reversed faults were then considered. A consideration of possible modes of formation led to the conclusion that the words "upthrow" and "downthrow" indicate no more than the relative displacement of the two sides of the fault. Passing on to the word "overthrust," the president pointed out that it implied the two concepts that the upper block was thrust over the lower, and that its displacement was due to the action of some external fault. With regard to the former, there is no means of deciding, from observations within the area of the overthrust, whether the upper or the lower block had been displaced or had remained stationary. With regard to the latter, it was deduced that the movements must have taken place piecemeal, and that the cause must have been generated within the area affected. As it is difficult to conceive of any such action taking place in the dead matter of the upper block, the conclusion is suggested that the originating cause lay in the lower, and the "overthrust" becomes an "undercrawl."

February 23.—Mr. R. D. Oldham, president, in the chair.—Prof. W. J. **Sollas**: *Saccammina Carteri*, Brady, and the minute structure of the Foraminiferal test. An investigation was made into the composition and structure of the test in the vitreous and porcellanous Foraminifera. In both groups the substance of the test consists wholly of calcite. The distinctive difference lies in the granular and felted structure which characterises the porcellana. Perforate Foraminifera and porcellanous forms occurring in association with Saccammina retain the original structure of their tests; the structure of Saccammina is not inconsistent with that of the arenaceous Foraminifera, and thus one is led to assign this fossil to the group originally proposed for it by Brady.—Dr. T. S. **Wilson**: Notes on the views of the late Prof. Charles Lapworth with regard to spiral movements in rocks during elevation or depression. During Prof. Lapworth's only visit to Wengen Alp, near Lauterbrunnen, he was able to infer the presence of rock-circles (due to spiral movements) some hundreds of feet up the hillside. Prof. Lapworth's theory of wave-movement is applied to solids, and the type of deformation which a cube would undergo if acted upon by wave-crests and wave-troughs from three different directions is discussed. By this method of investigation it is possible to demonstrate the conditions under which shearing would take place in the centre of the cube, along the main septal line between the positive and the negative portion of the fold.

Association of Economic Biologists, March 11.—Sir David Prain in the chair.—Dr. J. **Davidson**: The cells of plant tissues in relation to cell-sap as the food of Aphids. After describing the sucking apparatus of Aphids, the relation of the stylet to the plant tissues was considered, particular regard being paid to the course of the puncture, the effect upon the cell contents, the tissues affected, and the food value of saps at different ages of the plant. The very interesting relation between the size of Aphids upon various food-plants was discussed in the light of the difficulties that this introduces in specific determinations.—E. R. **Speyer**: Ceylon Ambrosia beetles and their relation to problems of plant physiology. Of the sixty-six Scolytid beetles in Ceylon associated with Ambrosia fungi, thirty-two belong to the genus Xyleborus. The bionomics of these beetles was briefly described, and an account given, illustrated by very fine specimens, of the tunnelling they make in their host trees. The pure cultures of degenerate Ascomycetous fungi maintained by the insects in their tunnels were described, each species of beetle having its own particular fungus, and a number of hypotheses were advanced to explain them. The paper closed with a brief review of the various insect groups which are known to cultivate fungi and of the organisms maintained.

EDINBURGH.

Royal Society, March 7.—Prof. F. O. Bower, president, in the chair.—Prof. A. R. **Horne**: A graphical method of determining shear influence lines and diagrams of maximum shearing force for a beam subjected to a series of concentrated rolling loads. The paper describes a graphical method of constructing shear influence lines. These lines are of importance to civil engineers in connection with the design of railway bridges and other structures which are subjected to rolling loads. They are of special importance in structures of reinforced concrete. Up to the present it has been the practice to determine these influence lines by calculation, which process becomes very laborious when the number of loads is considerable, as, for example, in the case of the wheel loads of a locomotive. The method is extended to make possible the determination of the maximum shearing force which occurs at each section in the length of the bridge or structure without any calculation being necessary.—Dr. J. M'L. **Thompson**: Studies in floral morphology. No. 2: The staminal zygomorphy of *Couroupita guianensis*, Aubl. In this communication the development of the remarkable lopsidedness of the flowers of Couroupita (the cannon-ball tree) is described. A general description of the tree itself is provided from the author's observations in Jamaica, and the crowded inflorescences and massive spherical fruits are illustrated. It is shown that the most conspicuous floral features of Couroupita are due to the separation of the male organs into two portions during development. The first is a fleshy ring round the style and bearing numerous short stamens, all of which produce small pollen-grains. The second is a long, strap-shaped, fleshy structure which is borne on the outer side of the flower. It ends in a massive ovoid body hanging over the centre of the flower, and carries long, fleshy stamens which produce large pollen-grains. It is this large, fleshy body which is the chief cause of the lopsidedness of the flowers. In the course of its development it assumes remarkable features. At an early stage its component cells become very large compared with those of the remaining male organs. A cellular gigantism is thus begun which is maintained throughout its entire history. It is to this cellular gigantism and to the active growth which accompanies it that the lopsidedness or zygomorphy of the stamens is due. The communication was illustrated by photographs and drawings showing the habit of the cannon-ball tree and the structure of its flowers and fruits, and formed the preface to a general study of the floral characters of the genera with which Couroupita is allied.

PARIS.

Academy of Sciences, February 21.—M. Georges Lemoine in the chair.—H. **Deslandres** and V. **Burson**: Researches on the atmosphere of stars. The recognition of stars which show the same bright lines as are observed in the sun. As the result of a search for bright chromospheric lines in stars, particularly in stars of the F, G, and K types, the K_2 and H_2 lines have been detected in eight stars and the K_2 line alone in two others, and a list of these stars is given. Only one of these, α Auriga, is of the solar G type.—P. **Termier** and L. **Joleaud**: The overlapping fragments of Propiac (Drôme), evidence of a great sheet of alpine origin, pushed, before the Miocene, on to the valley of the Rhône.—F. **Widal** and P. **Vallery-Radot**: Desensibilisation and resensibilisation at will in a patient anaphylactised to antipyrine.—G. **Gouy**: Aplanetism and the law of sines.—C. **Guichard**: Certain networks which occur in the study of the congruences belonging to a linear complex.—M. **de Sparre**: Calculation of the ram stroke in a pipe supplying a turbine with strong reaction.—P. **Vuillemin**: Endogenous zygomorphosis in flowers normally actinomorphs.—Sir Ernest Rutherford was elected a correspondant of the Academy for the section of general physics in succession to A. Michelson, elected foreign associate, and Jules Bordet correspondant for the section of medicine and surgery in succession to the late Pierre Morat.—R. **Wavre**: An equation of Fredholm in the complex domain and its application to the theory of systems of linear equations with an infinity of unknowns.—B. **Delaunay**: The solution of the indeterminate equation

$$qX^3 - pX^2Y + nXY^2 + Y^3 = 1.$$

—G. **Bouligand**: Certain modes of determination of the solutions of $\Delta u = \omega^2 u$.—M. **Holweck**: The absorption of X-rays of great wave-length. Connection between the X-rays and light.—G. **Claude**: The synthesis of ammonia under very high pressure: the present state of the experiments. In January, 1920, several members of the Academy saw the first working plant outside the laboratory; it produced 6 to 7 litres of liquid ammonia per hour. After various changes in the catalysers, at a second visit on November 20, 1920, the production was 60 to 70 litres of liquid ammonia per hour, or 1·25 tons per day. A compressor has now been built capable of compressing 700 cubic metres of the gas mixture per hour to 900 atmospheres, equivalent to 5 tons of anhydrous ammonia per day.—A. **Portevin**: The electrical resistance of the nickel-steels. A comparison of the resistances of a series of nickel-steels published by the author in 1909 with the measurements given later by O. Boudouard for a similar series shows that the figures are, in general, concordant, except in certain alloys which present large differences. It is now shown that the heat treatment is not without influence on the resistance, the same bar giving different figures according as it was allowed to cool down from 1000° C. in four hours or three days.—A. **Damiens**: Contribution to the study of the system iodine-tellurium. Study of the evaporation. The results confirm the conclusions given in earlier communications based on thermal or metallographic analysis. No evidence of the existence of a tellurium sub-iodide was obtained.—M. **Chopin**: Relations between the mechanical properties of dough and the lightness of the bread produced from it.—J. **Bougault** and P. **Robin**: The iodamidines. Benziodamidine undergoes an unexpected reaction when treated with acetic anhydride, a compound of the latter with benzdi-iodamidine being produced. This is stable in air, but is instantly decomposed by water with liberation of iodine.—A. **Guébhard**: The orthogonality of the systems of ridges of the earth's crust.—R. **Chudeau**: The ancient hydrography of the Sahara.—L. **Cayeux**: The idea of a general submarine metamorphism deduced from the alteration of the Jurassic oolitic iron minerals, contemporary with their deposit.—P. **Glangeaud**: The earthquake of October 3, 1920, which affected a large part of the volcanic regions of the Central Massif. This earthquake was not severe; the second shock, at 4.57 a.m., woke the population and caused oscillations of walls and furniture and the ringing of church bells, but little damage resulted. Earlier seismic disturbances (June to December, 1913) in the same region are recalled, and another, more severe, in August, 1892.—P. **Négris**: The subsidence of the Mediterranean coasts of France.—A. **Briquet**: The lowlands of Picardy south of the Somme.—J. **Pavillard**: The reproduction of *Chaetoceros Eibenii*.—P. **Delauney**: New researches concerning the extraction of the glucosides in some indigenous orchids; the identification of these glucosides with loroglossin. This glucoside has been shown to be present in *Cephalanthera grandiflora, Ophrys apifera,* and *Orchis bifolia*. Its identity with the loroglossin extracted by Bourquelot and Bridel from *Loroglossum hircinum* was proved by direct comparison of the melting points and by its reactions.—M. **Molliard**: The teratological phenomena occurring in the floral apparatus of the carrot as the result of injuries.—H. **Harlé**: A double curve representing very exactly sphygmometric oscillations.—MM. **Chaffard**, P. **Brodin**, and **Grigaut**: The arrest of uric acid in the liver. During digestion a proportion up to 50 per cent. of the uric acid entering by the portal vein is retained by the liver. If the animal is fasting, the proportion of uric acid in the blood entering and leaving the liver is unaltered.—A. **Dehorne**: The meiotic process in the spermatogenesis of the salamander and the triton.—C. **Champy**: The correlations between the male sexual characters and the various elements of the testicle in amphibians. Study of *Triton alpestris*.—Anna **Drzewina** and G. **Bohn**: Variations of susceptibility to harmful agents with the number of animals treated.—E. **Rabaud**: Variations in instinct and their production at will in various spiders.—P. **Lesne**: A breeding-ground of the fruit-fly (*Ceratitis capitata*) in the neighbourhood of Paris. In 1900, 1906, 1914, and 1919 the larvæ of Ceratitis were found in late pears at Asnières and Courbevoie, from which it would appear that this insect, originating in tropical countries, has become acclimatised near Paris.—E. **Kayser**: The influence of luminous radiations on azobacter.—H. **Spahlinger**: The treatment of human tuberculosis.—M. **Rappin**: Vaccination in tuberculosis.

WASHINGTON, D.C.

National Academy of Sciences (Proceedings, vol. vi., No. 6, June, 1920).—R. **Pearl** and L. J. **Reed**: The rate of growth of the population of the United States since 1790 and its mathematical representation. Parabolic, logarithmic, and exponential curves of population are discussed, the last giving a particularly close fit and, presumably, being better suited to prediction by extrapolation.—A. G. **Webster**: The Springfield rifle and the Leduc formula. The rifle gives results in accordance with the formula.—T. B. **Johnson**, A. J. **Hill**, and E. B. **Kelsey**: Alkyl amides of *iso*-thiocyanacetic acid. A report of a practical method of synthesis by which anilides of *iso*thiocyanacetic acid may be obtained. It seems safe to conclude that any *iso*thiocyanate formed by interaction of potassium thiocyanate with a secondary chloroacetanilide will be unstable.—H. **Shapley**: Studies of magnitudes in star clusters. XI.: Frequency curves of the absolute magnitude and colour index for 1152 giant stars. The clusters the stars of which are included in the discussion of absolute magnitude are Messier 3, 5, 11, 13, 15, 30, and 68 and N.G.C. 4147 and 7006. The present study is limited to stars brighter than zero magnitude. For the luminosity curves it is restricted to Messier 3, 11, and 13. The results have many points of interest.—T. H. **Gronwall**: The distortion in conformal mapping when the second coefficient in the mapping function has an assigned value.—A. G. **Webster**: The connection of the specific heats with the equation of state of a gas. A critical discussion of the statement that if a fluid obeys a characteristic equation of the form $V=F\ (P/T)$, the specific heats are independent of the pressure.—F. E. **Bartell**: Anomalous osmose. Anomalous pressures are those which do not conform to the gas law; they may be greater or less than the normal values, and abnormality may be so great as to result in so-called negative osmose. Hypotheses as to the electrical states which may be associated with the membrane system and may account for abnormal osmotic effects are discussed.—A. L. **Foley**: A photographic method of finding the instantaneous velocity of sound-waves at points near the source. The variation of the velocity from 666 metres per second to 380 metres is observed.—T. H. **Gronwall**: Conformal mapping of a family of real conics on another.—S. **Wright**: The relative importance of heredity and environment in determining the piebald pattern of guinea-pigs. A detailed analysis of an extensive series of experiments carried on by the Bureau of Animal Industry since 1906. In the control stock, variations in pattern are determined to about 42 per cent. by heredity and 58 per cent. by irregularity in development, leaving nothing for tangible environmental factors. In the inbred family the corresponding figures are 3 per cent. for heredity, 5 per cent. for tangible environment, and 92 per cent. for irregularity in development. The figures for the mean square deviations check well with theory.—E. W. **Berry**: Fossil plants from the Late Cretaceous of Tennessee. The present discoveries disclose the remains of 124 species complete enough for descriptive purposes, of which 86 are new to science.

Books Received.

Shasta of the Wolves. By Olaf Baker. Pp. vii+276. (London and Sydney: G. G. Harrap and Co., Ltd.) 6*s*. net.

Anthracene and Anthraquinone. By E. de Barry Barnett. Pp. xi+436. (London: Baillière, Tindall and Cox.) 25*s*. net.

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Monographien über die Zeugung beim Menschen. By Dr. Hermann Rohleder. Band v., Die Zeugung bei Hermaphroditen, Kryptorchen, Mikrorchen und Kastraten. Pp. x+143. Band vii., Die künstliche Zeugung (Befruchtung) im Tierreich. Pp. x+128. (Leipzig: G. Thieme.) 42 marks each vol.

Elementary Notes on Conifers. By A. H. Church. (Botanical Memoirs, No. 8.) Pp. 32. (London: Oxford University Press.) 2*s*. net.

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The Origin and Problem of Life: A Psycho-Physiological Study. By A. E. Baines. Pp. xii+97. (London: G. Routledge and Sons, Ltd.; New York: E. P. Dutton and Co.) 3*s*. 6*d*. net.

Tables of Physical and Chemical Constants and some Mathematical Functions. By Dr. G. W. C. Kaye and Prof. T. H. Laby. Fourth edition. Pp. vii+161. (London: Longmans, Green and Co.) 14*s*. net.

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Prevention of Venereal Disease. (Being the Report of and the Evidence Taken by the Special Committee on Venereal Disease.) Pp. xxxv+236. (London: Williams and Norgate.) 21*s*. net.

Memoirs of the Geological Survey: England and Wales. The Water Supply of Norfolk from Underground Sources. By William Whitaker. Pp. iv+185. (London: H.M. Stationery Office.) 10*s*. net.

The Carnegie United Kingdom Trust. Seventh Annual Report (for the Year ending 31st December, 1920). Pp. iii+62. (East Port, Dunfermline.)

A Practical Handbook of British Birds. Part x. Pp. 81–176. (London: Witherby and Co.) 4*s*. 6*d*. net.

Radioaktivität und die Neueste Entwicklung der Lehre von den Chemischen Elementen. By Prof. K. Fajans. Dritte auflage. (Sammlung Vieweg, Haft 45.) Pp. viii+124. (Braunschweig: F. Vieweg und Sohn.) 6.50 marks.

Grundzüge der Einsteinschen Relativitätstheorie. By Prof. August Kopff. Pp. viii+198. (Leipzig: S. Hirzel.) 36 marks.

Edina Geographies. By T. Franklin. Book i.: The British Isles. Pp. 64. 1*s*. 8*d*. net. Book ii.: Europe. Pp. 72. 1*s*. 9*d*. net. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.)

A Little Book on Map Projection. By Mary Adams (Dr. W. Garnett). New and revised edition. Pp. viii+112. (London: G. Philip and Son, Ltd.; Liverpool: Philip, Son and Nephew, Ltd.) 5*s*. 6*d*. net.

Quaker Aspects of Truth. By Dr. E. Vipont Brown. Pp. 156. (London: The Swarthmore Press, Ltd.) 5*s*. net.

The Coco-Nut. By Prof. Edwin B. Copeland. Second edition, revised. Pp. xvi+225. (London: Macmillan and Co., Ltd.) 20*s*. net.

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Annual Reports on the Progress of Chemistry for 1920. Issued by the Chemical Society. Vol. xvii. Pp. x+264. (London: Gurney and Jackson.) 7*s*. 6*d*. net.

Education and World Citizenship. An Essay towards a Science of Education. By J. C. Maxwell Garnett. Pp. x+515. (Cambridge: At the University Press.) 36*s*. net.

Dictionary of British Scientific Instruments. Issued by the British Optical Instrument Manufacturers' Association. Pp. xii+335. (London: Constable and Co., Ltd.) 21*s*.

Diary of Societies.

THURSDAY, MARCH 17.

INSTITUTION OF NAVAL ARCHITECTS (at Royal United Service Institution), at 11.—R. J. Walker and S. S. Cook: Mechanical Gears of Double Reduction for Merchant Ships.—E. W. Blocksidge: Life-saving Appliances on Cargo and Passenger Vessels.—M. E. Denny: The Design of Balanced Rudders of the Spade Type.

INSTITUTION OF NAVAL ARCHITECTS (at Royal United Service Institution), at 3.—H. B. W. Evans: Standardisation of Data for Airship Calculations.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. G. C. Simpson: The Meteorology of the Antarctic.

CHEMICAL SOCIETY (Annual General Meeting), at 4.

ROYAL SOCIETY, at 4.30.—Lord Rayleigh: The Colour of the Light from the Night Sky.—R. O. Street: The Dissipation of Energy in Permanent Ocean Currents, with Some Relations between Salinities, Temperatures, and Currents.—S. Datta: The Vacuum Arc Spectra of Sodium and Potassium.—W. E. Garner and C. L. Abernethy: Heats of Combustion and Formation of Nitro-compounds. Part I. Benzene, Toluene, Phenol, and Methylaniline Series.—E. K. Rideal: The Catalytic Dehydrogenation of Alcohols.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. Whitfield: Some Points in the Etiology of Skin Diseases (Lumleian Lectures).

LINNEAN SOCIETY, at 5.—W. B. Alexander: The Vertebrate Fauna of Houtman Abrolhos Islands, West Australia.—Prof. P. Fauvel: Annélides Polychètes de l'Archipel Houtman Abrolhos recueillies, par Prof. W. J. Dakin.—F. Chapman: Sherbornina: A New Genus of Foraminifera from Table Cape, Tasmania.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.—T. C. Benians: The Presence of Catalytic Enzymes as an Aid to Diagnosis of Hair Infections.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Capt. D. Nicolson: Flying-Boat Construction.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—E. H. Clifford: Scheme for Working the City Deep Mine at a Depth of 7000 feet (adjourned discussion).—A. E. Pettit: Notes and Records of Mining Costs.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Sir William Noble: The Long-distance Telephone System of the United Kingdom.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.30.—J. T. Chalk: Continuous Beams.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting) (at 28 Victoria Street), at 7.30.—H. B. Benny and D. J. Macklin: Modern Tendencies in Automobile Engine Design.

SOCIETY OF ARCHITECTS (at 28 Bedford Square), at 8.—H. Bagenal: Acoustics.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8. —Major A. Garrard and Others: Motor-Car Headlights: Ideal Requirements and Practical Solutions.

INSTITUTION OF NAVAL ARCHITECTS (at Royal United Service Institution), at 8.—Prof. T. B. Abell: A Study of the Framing of Ships.

RÖNTGEN SOCIETY (in Architecture Theatre, University College), at 8.15.—Dr. E. A. Owen and Miss Phyllis K. Bowes: X-Ray Dosage, with Special Reference to the Barium Platino-cyanide Pastille.

HARVEIAN SOCIETY (at Town Hall, Paddington Green), at 8.30.—Dr. L. Williams: The Thymus Gland in Everyday Life.

FRIDAY, MARCH 18.

INSTITUTION OF NAVAL ARCHITECTS (at Royal United Service Institution), at 11.—K. G. Finlay: The Spacing of Transverse Bulkheads. —A. M. Robb: Deflections of Bulkheads and of Ships.—J. J. King-Salter: Some Experiments on Tallows in their Use for the Launching of Ships.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—J. Faulder and Mr. Colledge: Ears under Modern War Conditions.

MONTESSORI SOCIETY (at University College), at 5.45.—F. Watts: Common Sense about Intelligence Testing.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. E. G. Coker, K. C. Chakko, and M. S. Ahmed: Contact Pressures and Stresses.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—T. E. Dimbleby: Hand-operated Appliances for Lifting and Transporting, with Particular Reference to Application in Awkward Circumstances.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Royal Army Medical College, Grosvenor Road), at 8.15.—Col. P. S. Lelean: Models of Some Sanitary Devices for the Tropics.—Lt.-Col. J. C. Kennedy: The Pathological Histology of Tropical Sore.—Lt.-Col. H. Marrian Perry: A Helminthic Infection in Relation to Bacterial Invasion of Tissues.—Major F. N. Coppinger: Preliminary Work in Connection with Detoxicated Dysentery Vaccines.—Dr. J. G. Thomson and Dr. A. Robertson: Association of Charcot-Leyden Crystals with *Entamoeba histolytica*.—Dr. H. St. J. Brooks: *Leptospira icteroides* and *Leptospira icterohaemorrhagiae*. —Dr. P. Manson-Bahr: *Bacillus coli* Infections of Tissues.—Miss E. M. Baxter and Dr. A. J. Eagleton: Can Syringes be Sterilised by Means of Oil?—Dr. A. Castellani and Dr. F. E. Taylor: Identification of Sugars and Other Carbohydrates by a Mycological Method.—C. A. Hoare: Demonstration of Trypanosomiasis of British Sheep.—Lt.-Col. S. P. James: A Case of Leprosy.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Prof. W. D. Halliburton: Physiological Advance: The Importance of the Infinitely Little (The Mackenzie-Davidson Memorial Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Frederick Bridge: The Researches of a Musical Antiquarian.

SATURDAY, MARCH 19.

BRITISH MYCOLOGICAL SOCIETY (in Botany Lecture Theatre, University College), at 11.—Dr. W. Brown: Studies in the Physiology of Parasitism.—A. D. Cotton: The Ministry of Agriculture's Plant Disease Survey.—Dr. P. Haas: The Use of Carrageen in Place of Agar as a Culture Medium.—Miss A. Lorrain Smith: Lichens and Transmigration.—Mrs. N. L. Alcock: Rhizoctonia Disease of Scots Fir.—Dr. A. S. Horne: A Polymorphic Aposphæria.—R. Paulson: Protococcus as the Gonidium of a Lichen.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Electricity and Matter.

MONDAY, MARCH 21.

INSTITUTE OF ACTUARIES, at 5.—G. S. W. Epps: Superannuation Funds.

ROYAL SOCIETY OF ARTS, at 8.—Major G. W. C. Kaye: X-rays and their Industrial Applications.

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court), at 8.—Dr. W. R. Ormandy and Others: Discussion on Electric Shadows and Wireless Telegraphy.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—J. G. Turner: The Relation of Dental Sepsis to Rheumatism and Allied Conditions.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.

TUESDAY, MARCH 22.

ROYAL HORTICULTURAL SOCIETY, at 3.—Mrs. Arber: Some Early Herbals.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—A. Peake: The Southern and Western Suburbs Ocean Outfall Sewer, Sydney, New South Wales.—W. E. Bush: The Main Drainage of Auckland.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Dr. Parkes Weber: Thrombosis of the Inferior Vena Cava and Both Renal Veins.—Dr. Nathan Raw: The Treatment of Tuberculosis with Attenuated Tubercle Vaccines.

MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—Dr. G. F. Herbert Smith: Linarite, Caledonite, and Associated Minerals from Cornwall.—Prof. H. Hilton: The Vibrations of a Crystalline Medium.—Prof. R. Ohashi: Augite from Nishigatake, Hizen, Kiu-shu, Japan.—Dr. G. T. Prior: The Adare and Ensisheim Meteorites.—W. Barlow: Model Representing the Atomic Structure of Calcite and Aragonite.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Report on the Additions to the Society's Menagerie during the month of February, 1921.—Prof. J. Cossar Ewart: The Nestling Feathers of the Mallard, with Observations on the Composition, Origin, and History of Feathers.—E. T. Newton: Fossil Bird-remains from Sardinia, Corsica, and Greece, collected by Dr. Forsyth Major.—G. C. Robson: The Molluscan Genus Cochlitoma and its Anatomy, with Remarks upon the Variation of Two Closely-allied Forms.—H. E. Andrews: The Oriental Species of the Genus Callistomimus (Coleoptera, Carabidæ).

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Miss Barbara Low: Psycho-Analysis and the Educator.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—V. Poliakoff and Dr. C. T. Hagberg Wright: Russia: Past and Present.

FARADAY SOCIETY (at Chemical Society), at 8.—Prof. A. W. Porter: Some Aspects of the Scientific Work of the late Lord Rayleigh (Presidential Address).—W. E. Hughes: The Forms of Electro-deposited Iron and the Effect of Acid upon its Structure. Part I. Deposits from the Chloride Bath.—S. Field: The Electrolytic Recovery of Zinc.—Prof. A. Findlay and V. H. Williams: Notes on the Electrolytic Reduction of Glucose.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Dr. F. G. Crookshank: The Significance of Mongolian Imbecility.

WEDNESDAY, MARCH 23.

GEOLOGICAL SOCIETY, at 5.30.—E. B. Bailey: The Structure of the South-West Highlands of Scotland.

CONTENTS.

PAGE