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Imperial Water Power.

THE issue of the third and final report of the Water-Power Committee of the Conjoint Board of Scientific Societies is a timely reminder of the importance of a matter which has strangely failed to engage the attention of the community at large, notwithstanding its general perspicacity of judgment in regard to industrial enterprise. It was pointed out in these columns in September, 1918, that the national stores of solid fuel were far from inexhaustible, and that they were being depleted with reckless prodigality, while, simultaneously, another source of energy, viz. water power, ready to hand and only awaiting development, was being allowed to run to waste. Inevitably, sooner or later, the value of this natural supply of energy would be bound to demonstrate itself, but meanwhile no spendthrift could be more indifferent to the squandering of his patrimony than the average citizen to the loss of this form of his country's wealth. Although by no means so well endowed as some other countries, it is estimated that Great Britain has a potentially utilisable amount of water power of more than a million horse-power. Less than a tenth of it is actually developed. This means that some nine hundred thousand horse-power is being dissipated, minute by minute—the equivalent of the consumption of at least four to five million tons of coal per annum.

It is true that the report before us states that, as regards the United Kingdom, "active investigations are being made and definite steps taken by the Committee appointed by the Board of Trade." And we are, of course, aware that hydrographical investigations require time, often a very long time, extending over periods of years which may well run to twenty or even more. Therefore we have no wish to indulge in premature criticism, but we are bound to remark that the only evidence which has so far been adduced of definite projects in view has been the ill-timed announcement of the Severn barrage scheme—a scheme of such tremendous magnitude, founded on data so inadequate, that the public refused point blank to have anything to do with it.

In the present notice we confine our observations to the subject-matter of the report, and its fourteen pages demonstrate in the most pointed way the disparity existing between the steps taken in the United Kingdom and those in other countries for the development of natural sources of water power. Let us extract the following table comparing the summarised figures of the hydraulic powers of the world:—

	Hydraulic horse-power		Percentage of available power at present developed.
	Available.	Developed.	
Europe (Germany, Italy, Switzerland, Spain, Sweden, Austria-Hungary, France, and Norway)	47,300,000	8,450,000	18·0
United States ...	32,000,000	6,500,000	20·3
British Empire ...	60,000,000	3,000,000	5·0

The comparison is unfavourable enough, but the case of the British Empire becomes much worse if we except Canada, where about 72 per cent. of the British total is developed. Reconstituting the table, with the United States and Canada jointly included in North America, we get:—

	Hydraulic horse-power		Percentage of available power at present developed.
	Available.	Developed.	
Europe	47,300,000	8,450,000	18·0
North America ...	50,800,000	8,805,000	17·3
British Empire (except Canada) ...	41,200,000	695,000	1·7

It is scarcely a matter for wonder that the Committee's comment is that "the figures afford striking evidence of the relative scope for development through the Empire." The Committee adds:—

"Taking the Empire as a whole, no attempt is being made to ascertain the total resources, to secure any uniformity in methods of investigation and recording of data, to encourage such investigations as are being made, or to collect the information as it becomes available at a central bureau. At present not even an approximately complete inventory exists, much less the practical

and commercial information that would assist development of this important national resource."

The report contains a summary of the information which, since the issue of the earlier reports, has come to hand respecting India, Ceylon, British East Africa, British Guiana, New South Wales, and Victoria. The information, though serviceable, is of the scantiest character, and merely touches the fringe of the subject.

The Committee then alludes to the proposed Imperial Water-Power Board and makes suggestions as to the principal objects for which such a board would be formed. The following conclusions are arrived at:—

A.—That, in view of the immense water-power resources known to exist in the Empire and of their commercial value, it is of urgent importance that adequate measures should be taken to promote the development of these resources.

B.—That, in many parts of the Empire, it is most desirable that records of river-flow should be instituted and maintained if they are to constitute a safe commercial basis for power development.

C.—That the creation of an Imperial Water-Power Board, with extensive powers to carry out a comprehensive policy for stimulating, co-ordinating, and, where necessary, assisting such development throughout the Empire, is needed.

D.—That a great impetus would be given to the investigation of water resources in the Dominions and Dependencies, by the creation of such a central board to assist and to record such information for the assistance of commercial investors.

E.—That the greater uniformity of methods of investigation and recording to be secured by such a board would much increase the commercial value of the information.

F.—That an Imperial Water-Power Conference be convened in London, if feasible, at an early date. The Committee understands that a proposal has been made to hold such a conference, and that this has been cordially received by the representatives of those of the outlying portions of the Empire which are most directly concerned. Such a conference would offer the opportunity of discussing matters of policy, administration, uniformity of investigation and record, in connection with water-power development, and could not fail to have a useful effect on such development.

The proposal for an Imperial Water-Power Conference to be held at an early date is particularly welcome, and we trust that it will be adequately supported. The time is certainly ripe for a gathering of this kind, and it is to be hoped that it will serve to kindle practical interest in a subject of the most vital importance to the industrial development of the Empire.

We cannot conclude without expressing the great indebtedness of the scientific community to the Committee for its painstaking researches, and especially to its energetic secretary, Prof. A. H. Gibson, who has admirably collated and summarised the material furnished to the Committee and, by his untiring efforts, has rendered possible the presentation of the three successive reports.

The Denomination "Chemist."

BRITISH chemists are placed in the anomalous position, not occupied by their brethren in other civilised countries, of sharing their denomination with practitioners of a different craft—namely, pharmacy. It is, in fact, only by courtesy of the Pharmaceutical Society that they call themselves chemists, because, unless they hold a qualification from that body, they are not legally entitled to do so. The Pharmacy Acts Amendment Bill, read for the first time in the House of Commons on November 3, aims at correcting this error in occupational nomenclature by conferring on the Institute of Chemistry alone the authority to designate any person a "chemist," simultaneously giving to the Society of Pharmacy and Drug Store Proprietors of Great Britain power to place persons on the pharmaceutical register.

It is greatly to be hoped that this, or some similar measure, may find its way on to the Statute Book. The disability it seeks to remove has long been the source of inconvenience and vexation to chemists, but prior to the war it might have been claimed that the matter was a domestic one and did not affect the public welfare. Now, however, it is more than ever important that the public should be assisted in realising the vital necessity of chemistry, in common with other branches of science, for national well-being and progress. Part of the ignorance which prevails in the public mind concerning chemistry may be traced to the nominal association of the subject with pharmacy, an association from which pharmacists themselves do not derive any benefit, and which has led them to adopt a variety of sub-titles, including "cash chemist," "stores chemist," and "Continental chemist." Indeed, it may be argued that pharmacists also have suffered from this confusion, because the daily Press, in despair of explaining the position to the public, commonly refers to chemists as "scientific chemists," thereby implying that pharmacists are not scientific, and thus casting an

undeserved slur on an honourable and useful calling.

It is quite rational that many pharmacists should exhibit reluctance to part with a title which they have legally held since the Act of 1851, and one hallowed by the fact that some of the early chemists—for example, Scheele—were practising pharmacists. In the course of years, however, and following the necessary classification of innumerable chemical observations in a distinct branch of scientific knowledge, the extension of chemistry has passed almost entirely from pharmacists, who are thus designated by a misnomer. It is the purpose of the Pharmacy Acts Amendment Bill to rectify this irregularity as from the first day of January, 1925.

In view of the laudable object of the Bill and the support which the principle at least might be expected to receive from chemists, it is difficult to understand the action of the promoters in holding themselves aloof from the Institute of Chemistry, and not even consulting the council of that body. Consequent on this omission, the official attitude of the Institute has now been set forth in a letter from the registrar to the promoters stating that the council would welcome any legislation tending to remove the present confusion, which it deplores; but it dissociates itself from the suggestion that it should be represented on the central council, which, as proposed in the Bill, would be concerned with the pharmaceutical register. This attitude will be approved alike by pharmacists and by chemists, for the latter have not the slightest claim to participate in the registration of pharmacists; chemists have never suggested, or even contemplated, an action which pharmacists justifiably would resent as an interference with their own functions.

Echinoderm Larvæ and their Bearing on Classification.

Studies of the Development and Larval Forms of Echinoderms. By Dr. Th. Mortensen. Pp. iv + 261 + 33 plates. (Copenhagen: G. E. C. Gad, May, 1921.) 2*l.* 2*s.*

THE development of Echinoderms from the egg presents one of the most striking of life processes known to us. The changes through which the individual passes are even more remarkable than those accompanying the more familiar metamorphosis of a caterpillar into a butterfly. The egg develops directly into a free-swimming larva of bilateral structure, adapted in most cases for pelagic life; within this larva there is gradually formed a body with radial structure and special organs, which, being set free from the larva, grows into the adult sea-urchin, starfish, crinoid, or holothurian—an adult rarely free-floating and generally abiding in one place. It is almost as though there were an alternation of generations, as though the larva bore the young echinoderm as a mother bears a child; and this idea, though not really justified, is forcibly recalled by Dr. Mortensen's account of an ophiurid larva, which, after dropping the young brittle-star, proceeds to reconstitute its own body, and continues life as an independent individual. Dr. Mortensen even suggests, rather audaciously, that it may repeat the metamorphosis.

It is with those larvæ that are adapted to a pelagic life that Dr. Mortensen is mainly concerned. The adaptation consists largely in the development of long rod-like processes, generally known as arms, although they have nothing to do with any structures so called in adult echinoderms. These processes serve as balancers and aid the flotation of the tiny creature. In only a few forms, however, do the skeletal rods support any paddle-shaped expansion of the soft tissues, and in only one, here first made known by Dr. Mortensen, can they be moved like oars by means of special muscles.

The absolute distinction between the larva and the adult, combined with the difference of habitat and the difficulty of raising all the stages in an aquarium, has long hindered the attempt to assign the various larvæ to their respective species. They have, therefore, for practical convenience, been classified and named on an independent system. In the present work Dr. Mortensen's chief aim has been to decide how far this classification agrees with that of the adults, or, to put the matter in another way, how far the differences and resemblances of the larvæ throw light on the affinities of the adult genera and species. Previously the pelagic larvæ of about seventy various echinoderms had been identified, and Dr. Mortensen here describes the development of fifty-five forms previously unknown. The data, therefore, though relatively very few, are enough to warrant a discussion of the problem.

In so many instances do the larvæ of closely related species resemble one another, so often do the larvæ of allied genera agree in important characters, so distinct are the larval forms of the several orders no less than of the classes, that Dr. Mortensen is justified in his conclusion that similarity of larval structure implies the relationship of the respective adults. The converse proposi-

tion, that forms with essentially different larvæ are not nearly related even when there is some resemblance between the adults, may lead to dispute when applied to particular cases. But the conclusion can be tested by other characters. For instance, a Mediterranean sea-urchin, *Sphaerechinus granularis*, approaches Strongylocentrotus in certain features which have led Dr. H. L. Clark to refer it to that genus. Its larva, however, is found to agree with those of the Toxopneustidæ, not with those of Strongylocentrotus. A fairly good test is afforded by the minute structures of the pedicellariæ, and these confirm the conclusion drawn from the larvæ. Although we have as yet only random samples of larvæ from the thousands of living Echinoderm species, still observation, so far as it has gone, does indicate that here is new and valuable evidence of affinity.

In directing attention to this evidence, as when he demonstrated the importance of the microscopic characters of spines and pedicellariæ, Dr. Mortensen has provided the systematist with a new method. It is unfortunate that neither of these tests can (save in some exceptional specimens) be applied to fossils. They cannot oppose the palæontological argument, but they cannot assist it; we can only say that, for genealogical trees based on the evidence of dead ancestors to be correct, the arrangement of their ultimate living twigs must accord with the evidence of their larvæ and of their anatomy generally. In so far as the methods are sound, there can be no conflict between them. The unsound method is that which relies on only one or two characters and in addition too often ignores their historical development. The greater weight should always be attached to the older character. When palæontology cannot tell us directly which this is, we may assume that characters less likely to have been modified by changes in the environment are the older. That principle is, one supposes, consciously or subconsciously the basis of the ill-expressed statement that "anatomical characters" are more important than external characters. The microscopic structure of a minute spine is, whether "anatomical" or not, such a persistent character. Similarly, pelagic larvæ, living in an environment naturally subject to little change, must themselves remain long unchanged, and should therefore yield evidence of affinity more readily than do the later stages in their varied and variable surroundings.

It would be wearisome to repeat here the numerous particular conclusions which Dr. Mortensen bases on the resemblance of the larvæ. The Echinoidea yield the most results: one can recognise a distinct larval type for each of the orders Spatangoidea, Clypeastroidea, and, probably, Diademoidea, and for most of the main families in the regular Echinoids. The classification of the Ophiuroidea is, admittedly, so unsatisfactory that it has not been possible to correlate the accepted families with definite larval types, but for the Asteroidea this has been done to some extent. The larvæ of the Holothurians are not well known, and the Crinoids have not yet furnished a single pelagic larva.

Fortunately the study of the larvæ opens up more general questions, and many will wish to know whether Dr. Mortensen has anything to say on the interrelations of the classes or on the origin of the Echinoderms as a whole. He points out that the Brachiolaria larva of starfishes with its sucking disc, being found only among the more specialised forms, must itself be a late development, so that the sucker cannot be homologous with the stalk of the Crinoids. None the less Dr. Mortensen expresses his "perfect agreement" with the theory which derives all Echinoderms from a simple, bilaterally symmetrical creature—the Dipleurula—now represented by the earliest larval stage in each class, and which explains the five-rayed symmetry and the torsion of the internal organs as due to the fixation of the Dipleurula and its change into a sessile animal with upwardly directed mouth and vent. Seeing that this theory was published in 1900, it may be held to have attained its majority. The later theories of Simroth, A. H. Clark, and J. E. V. Boas are treated by Dr. Mortensen with something as near to contempt as this courteous writer ever permits himself. But as to the origin of the Dipleurula, Dr. Mortensen will express no positive opinion. He sees no connection with the Cœlentera. Certainly the transition was not direct, as Boas suggests; but a possible series of intermediate stages was sketched by the writer of the article "Echinoderma" in the "Encyclopædia Britannica," Editions X. and XI. (1902, 1911), an article always overlooked by writers outside Great Britain.

Other matters of general interest, such as geographical distribution or the influence of temperature, must be left for those who are wise enough to look for themselves at this clearly written, admirably illustrated, and well produced account of a long series of difficult observations. In these hard times we are more than usually indebted to the Carlsberg Fund, which has rendered possible the preparation and the publication of Dr. Mortensen's richly suggestive studies.

F. A. BATHER.

Electrotechnical Theory.

(1) *The Theory of the Induction Coil.* By Prof. E. Taylor-Jones. Pp. xi+217. (London: Sir I. Pitman and Sons, Ltd., 1921.) 12*s.* 6*d.* net.

(2) *The Theory of Direct-current Dynamos and Motors.* By John Case. Pp. xiii+196. (Cambridge: W. Heffer and Sons, Ltd., 1921.) 15*s.* net.

(3) *Engineering Electricity.* By Prof. R. G. Hudson. Pp. viii+190. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 13*s.* 6*d.* net.

(1) ALTHOUGH it is more than ninety years ago since Faraday made the first induction coil, yet it is only quite recently that a satisfactory working theory of it has been evolved. The problem is one of considerable commercial importance, for induction coils and magnetos are widely used for ignition purposes in gas and petrol engines as well as for X-ray work and radio-communication. Prof. Taylor-Jones has made a special study of the problem, and the theoretical results deduced from his oscillation transformer theory are in good agreement with experiment.

The principal hypothesis he makes is that after the interruption of the primary current the system acts like an oscillation transformer. The currents in both the primary and secondary circuits act like systems with two degrees of freedom. The wave of current in each circuit has two oscillatory components which have in general different frequencies and different damping factors. They sometimes also have different initial amplitudes.

The author's method of treatment is similar to that adopted by Drude. As the value of the current in the secondary at any instant varies along the length of the wire, and as it is practically impossible to discuss distributed mutual inductance, the author supposes that there is a "mutual coefficient" between the primary and the secondary, and a different "mutual coefficient" between the secondary and the primary. He is also forced to suppose that the distributed capacity of the coils can be imitated by localised condensers placed across their terminals. Making these assumptions he has to find the roots of an algebraical equation of the fourth degree in order to solve his differential equations. It is shown that in certain cases the solution can be simplified considerably.

This theory shows how to calculate approximately the size of the primary condenser of an induction coil in order to get the greatest difference of potential between the secondary terminals, while the experiments show that the simplified formulæ obtained by neglecting the resistances of the coils are a help in practical work. Very interesting photographs of the wave form of the secondary potential are shown, and useful discussions of the problems of the Tesla coil and the high-tension magneto are given. We can recommend this book to research workers.

(2) This book will prove very useful to students who are reading for a degree in engineering science. The author develops in a very intelligible way the theory underlying the design, operation, and testing of direct-current machinery. He discusses the dynamo as a machine for converting mechanical into electrical energy, and the motor as a machine for doing the reverse operation. The use of direct-current motors in traction systems is also discussed, and there is a chapter on boosters and multiple-wire systems. A special feature of the book is the large number of engineering problems given, many of which have been taken from recent university examination papers. It would have been an improvement if the answers to all of them had been given.

When discussing the heating and cooling of dynamos the author regards the heat dissipated as being mainly due to radiation. As a matter of fact, the great bulk of the heat dissipated is due to thermal convection. This is the reason why it is customary to make ventilating ducts so as to secure a good circulation of air, the convection increasing as the square root of the velocity of the air current. We notice that the author adopts the induction-factor method of discussing the motor problem—a method first given by Carus Wilson many years ago. It seems particularly helpful when discussing numerical examples. A very neat graphical method of obtaining the losses in a machine by letting it slow down and getting an angular velocity-time curve by means of a tachometer is also given, and the geometrical data found from it give the required constants.

We have found little to criticise in the book. In the statement of Faraday's law given on p. 1 it should be stated that the induced E.M.F. is due to the rate at which the flux of induction (not the number of lines of force) linked with the circuit is altering: the complete formula (11), p. 10, for the self-inductance of a pair of parallel wires is not correct, for the second term should be 1, and not 2. There is a mistake also in the numerical working out of the example at the top of p. 11.

(3) Junior students in technical colleges can be recommended to study Prof. Hudson's text-book. It can also be commended to the notice of engineers who desire to revise their knowledge of the principles on which electrical engineering

is based. The principles are clearly and concisely stated, the author's aim being to develop the reasoning power of the student, and not merely to give him disconnected facts.

The junior student who has no teacher will probably find many difficulties in the book. The two-wattmeter method of measuring power in three-phase circuits is given so concisely that we doubt whether any reader who comes across it for the first time will be able to follow the reasoning. We think also that it is a pity Kelvin's law for the maximum efficiency of power transmission lines is merely stated; a proof could have been given in two or three lines.

The author has adopted the recommendation of the International Electrical Commission, and calls the unit tube of induction the Maxwell. He, however, calls the unit of magnetic flux density —*i.e.* a Maxwell per square centimetre—the Gauss. The recommendation of the I.E.C. is that the unit of magnetic force be called the Gauss. Magnetic force is not mentioned at all, and up to a certain point the author seems to get on very well without it. His definition, however, of permeability as the ratio of the magnetic flux at a point in the medium to the magnetic flux at the same point if an infinitesimal portion of the medium at the point were removed and air substituted is open to criticism.

Teachers find it difficult to give a satisfactory definition of the capacity—or, as the Americans call it, the capacitance—of a condenser. In this book it is defined by means of the charging current for a given sine-shaped wave of potential difference applied to its electrodes, and this gets over many difficulties. Mercury arc rectifiers, which can often advantageously replace rotary—or, as the Americans call them, synchronous—converters receive a chapter to themselves. The book concludes with a large number of photographic reproductions of the latest types of electrical machinery and apparatus. Some of these, however—*e.g.* the electrolytic lightning arrester—are not described in the text. A. R.

British Scientific and Technical Books.

A Catalogue of British Scientific and Technical Books Covering every Branch of Science and Technology, carefully Classified and Indexed. Prepared by a Committee of the British Science Guild. Pp. xviii + 376. (London: British Science Guild, 6 John Street, Adelphi, W.C.2, 1921.) 10*s.* net.

IT would be difficult to discover many readers of NATURE who would not be interested in the present volume, and would not find it a useful addition to their libraries. Hitherto the information within its covers has been obtained only by the wearisome perusal of some 120 publishers' lists, with their varying methods of classification.

The volume is a result of a desire of the British Science Guild to make a complete record of scientific and technical books, other than those intended for primary schools and elementary volumes of like nature, in the current lists of publishers in the United Kingdom. No attempt at selection has been made by the Committee, and the present writer is of the opinion that this course is a wise one. There are many works which are condemned by one authority and yet are recommended by another. The whole difference lies in the point of vision and the purpose for which the work is wanted. This being so, it is far better to place before the inquirer a list of books on a given subject and let him make his choice, knowing as he probably does his own requirement. If skilled advice be needed, with such a list at hand it is probable that any expert would be willing to give advice.

The entries are arranged in subject order in a classification devised to be such that, so far as practicable, related subjects are placed near to one another, the titles under each head or subhead being arranged alphabetically according to authors' names.

If there is any doubt as to the particular group or groups in which a subject would appear, a reference to the alphabetical subject index at the end of the volume at once indicates where it will be found. This alphabetical subject index adds considerably to the value of the work, as it is a guide to the contents, rather than a mere indication of the titles, and it is evident that much care has been taken in its compilation. A very complete alphabetical list of authors, collaborators, and translators is also included.

The insertion of the date of publication of nearly every item is an extremely useful feature. This information very seldom appears in a publisher's catalogue, and one is left in ignorance as to whether a book is twenty years old, or the latest publication on the subject.

Apart from the purpose for which the work has been produced, it constitutes a valuable post-war survey of the British resources in this field of literature. With its aid some lacunæ may be disclosed which, it is hoped, British authors and publishers will be quick to fill.

The trustworthiness of the volume has been very thoroughly tested, and although some hundreds of items have been checked, the reviewer found no serious reason for criticism. A few prices are not correct, but this is only to be

expected considering the fluctuations in price which have occurred during the last few months. The titles of one or two important works do not appear, but inquiry elicits the information that they are out of print, and thus do not come within the scope of the book. What at first appears to be an omission of the valuable Reports on the Progress of Applied Chemistry, published by the Society of Chemical Industry, is evidently due to the decision that the books included should be obtainable through booksellers in the usual way. The reason for the inclusion of a work on "Sea-water Distillation" under the heading of General Chemistry is not quite easily explained, but it is probably due to a mechanical error in sorting. Such slight blemishes do not, however, detract from the value of the book, and considering the amount of tedious work which must have been incurred in its compilation, it is a matter for congratulation that so few occur.

Booksellers and librarians would be well advised to include a copy amongst their works of every-day reference, as they will find that it will save them a great deal of unnecessary labour.

The volume is well printed, and the binding should stand considerable wear and tear. An unusual feature is that the end papers are wholly reinforced with a fine gauze or "mull," in a manner which should tend to strengthen the binding very materially.

The British Science Guild has produced a notable volume, and it is much to be hoped that its sale will justify the expressed desire to issue an annual edition. F. W. CLIFFORD.

The Statecraft of Ancient Greece.

The Works of Aristotle. Translated into English under the editorship of W. D. Ross. Vol. 10, *Politica,* by B. Jowett; *Oeconomica,* by E. S. Forster; *Atheniensium Respublica,* by Sir Frederic G. Kenyon. (Unpaged.) (Oxford: At the Clarendon Press, 1921.) 15*s.* net.

THE new volume of the Oxford Aristotle will probably appeal to a wider range of readers than any of the others, because it deals with statecraft, theories of government, economics, and constitutions. The "Politics" is no doubt the best known of Aristotle's works outside the body of students who have had to read the treatises for university courses. This is in large part due to the splendid translation made by Jowett in 1885. It is this translation which is reprinted in the present volume, revised and brought up to date by Mr. W. D. Ross, the editor of the series. With it is included Mr. E. S. Forster's translation of "Œconomica," an Aristotelian work which is not by Aristotle, but attributed by the translator to a disciple who lived earlier than the second century B.C. The third work in the volume is the treatise on the constitution of Athens, discovered in a papyrus in 1891. The translation is that originally made by Sir Frederic G. Kenyon, but now revised by him and in part reconstructed from fragments since discovered.

When we read Aristotle we have to keep reminding ourselves that we live in a different world, for he seems to be discussing always our own modern problems. It is difficult to realise that questions so vital to us were commonplace in the ancient world, and we are often tempted to exclaim with the Hebrew preacher, "There is nothing new under the sun." It must be rather a shock to those who have heard of Thales of Miletus as the first of the great line of Ionian natural philosophers to be told that he once enriched himself by cornering the olive presses. Certainly the moral Aristotle draws is designed to show that the philosopher despises wealth, for he has the opportunity of acquiring great riches if he chooses to use his wisdom for a worldly end. The other story of the man of Sicily, presumably a banker, who used the money deposited with him to buy up the iron-ore, and made a profit for himself of more than 200 per cent., has a still more curious moral. The man was expelled from Syracuse as a dangerous person who might get too rich, but he was allowed to take his money with him! Aristotle's moral is that the State would do well to take example from him. Even "the Great Illusion" was exposed in the ancient world, and produced, in one instance at least, more effect than Mr. Norman Angell has produced in our generation. We are told that "Eubulus, when Autophradates was going to besiege Atarneus, told him to consider how long the operation would take, and then reckon up the cost which would be incurred in the time. 'For,' said he, 'I am willing for a smaller sum than that to leave Atarneus at once.' These words of Eubulus made an impression on Autophradates, and he desisted from the siege."

H. W. C.

Our Bookshelf.

The Outline of Science: A Plain Story Simply Told. Edited by Prof. J. Arthur Thomson. Pp. ii+40. (London: G. Newnes, Ltd., n.d.) 1*s.* 2*d.* net.

FROM its title this work (which is to be completed in about twenty parts) claims no more than to give an *outline* of science. Astronomy occupies

some twenty-four pages of part 1; it is necessarily treated very summarily, and much of the information is given by diagrams. This makes it essential that these should be accurate and self-explanatory. Fig. 2 is open to the criticism that it fails to show the great differences between the interplanetary spaces; the orbits are represented as equidistant, and Saturn's period is given as twelve years. Fig. 11 quite fails to show the sun's pre-eminence compared with the planets. The letterpress under the portrait of Prof. J. C. Adams is disfigured by the substitution of Neptune for Uranus as the perturbed planet. Fig. 6 (the total solar eclipse of 1919) is described as being taken at Greenwich, instead of Sobral, Brazil. On p. 23 it is stated that "mutual friction raises at least a large part of them (the meteors forming a comet) to white heat." This is quite improbable, since the meteors are travelling on parallel paths with practically equal velocities. In the large diagram illustrating the spectroscope the luminous body appears to be a star, since the sky is dark and other stars are shown. However, no object except the sun could throw a large, bright spectrum on a screen, and in this case a slit (absent from diagram) would be essential for showing the Fraunhofer lines.

There are several excellent reproductions of solar, lunar, planetary, and nebular photographs, and a bold coloured drawing of a gigantic solar prominence. The descriptive matter is attractively written, and includes a short exposition of the theory of giant and dwarf stars, and of the Moulton-Chamberlin planetesimal theory, which, however, postulated the approach of but one star to our system, not one for each planet, which latter would be utterly improbable.

A. C. D. CROMMELIN.

Die Ursachen der diluvialen Aufschotterung und Erosion. By W. Soergel. Pp. v+74. (Berlin: Gebrüder Borntraeger, 1921.) 18 marks.

IN translating the title of this suggestive work we are troubled by the term "diluvial," which has, we fear, become fixed in German terminology; also by the fact that we have no equivalent for the expressive word "Aufschotterung." The author refers the formation of the true Schotter, the boulder-beds, to epochs of cold semi-arid climate, when frost acted on a surface free from vegetation. Weathering was then mechanical. Valley-erosion, on the other hand, indicates a humid climate, when vegetation protected the rocks from block-denudation, when weathering was chemical, and when the free flow of water worked havoc with the preceding products of "Aufschotterung." Herr Soergel shows how even so large a cause as upheaval or subsidence of the land is unlikely to promote regional erosion or aggradation in a network of valleys running in different directions. The tilting or buckling of the land-surface in such a case leads to changes that vary from one district to another. Hence the author sees in the regional features of "diluvial" times in Europe evidence of repeated climatic change, and he finds support in the animal remains that are associated with deposits formed respectively in epochs of erosion and glacial aggradation. The "monoglacial" view is thus rejected; boulder-beds connected with epochs of erosion are merely local and do not indicate a continuity of the cold conditions that produced the great "Aufschotterungen."

G. A. J. C.

Flora of the Presidency of Madras. By J. S. Gamble. Part 4, *Rubiaceae to Ebenaceae.* Pp. 579–768. (London: Adlard and Son and West Newman, Ltd., 1921.) 10*s.* net.

THE present instalment of this handy little flora is mainly occupied with the two large families Rubiaceæ and Compositæ, the former including representatives of forty-five genera, and the latter of sixty-two. The Rubiaceæ include plants of widely varying habit; small-flowered, creeping, erect, or climbing herbs recall the development of the family in temperate climates, and shrubs or trees represent the tropical development. The latter include handsome flowered species, as in the Ixoras and Gardenias. *Hydrophylax maritima,* a succulent creeping herb, is a useful sand-binding plant on the dunes of the east and west coasts. Many genera familiar in temperate regions occur among the Compositæ in the hill districts; the Dandelion is an introduced weed both in the Nilgiris and the Pulney Hills. The nineteen species of the genus Senecio include, besides herbs of our ragwort type, several shrubby climbers; and Vernonia, with twenty-nine species, includes herbs, shrubs, and small trees.

In contrast with the rich development of the Ericaceæ and Primulaceæ in Northern India the Madras Presidency is very poorly represented. Ericaceæ comprise only one Gaultheria and one Rhododendron, and Primulaceæ six species in all, one of which, *Anagallis arvensis,* the pimpernel, occurs only in the blue-flowered form. The genus Primula is absent; but there are six genera of the allied family, Myrsinaceæ, one of which, Ægiceras, is a constituent of the mangrove forests of the sea-coasts and tidal creeks.

A Handbook of Laboratory Glass-blowing. By B. D. Bolas. Pp. vii+106. (London: George Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1921.) 3*s.* 6*d.* net.

ALTHOUGH it is without doubt desirable to have a professional glass-blower attached to a physical or chemical laboratory, a knowledge of simple glass-blowing is essential to students generally. While Mr. Bolas carries the subject rather further than the simple repair of apparatus, for he describes also the construction of glass laboratory ware, he gives clear and concise instructions for the manipulation of glass which should prove of considerable service to laboratory workers. Most of the operations are illustrated by clear line drawings of the various stages through which the material passes before it assumes its final form.

Stanford's New Map of the Pacific Ocean. Size 30 × 22½ in. (London: E. Stanford, Ltd., n.d.) Coloured sheet, 4*s.*; mounted to fold in case, 6*s.* 6*d.*

A MAP of the Pacific Ocean showing the distribution of political interests should prove useful at a time when international problems centre largely on that ocean. Messrs. Stanford have produced an excellent map which has the merit of being on Mollweide's equal area projection, and showing the main features of relief by layer colouring. Spheres of interest are shown by distinctive bands of colour and the principal submarine cables and wireless stations are clearly marked. A few corrections might be made in a later edition. The Banks and Torres Islands are within the joint Anglo-French administration of the New Hebrides and not under the High Commissioner of the Western Pacific. The Chesterfield Islets, although of very slight importance, form part of the French colony of New Caledonia. The Portuguese foothold in Eastern Timor should be marked. The small group of the Tasman Islands, north of the Solomons, used to be German territory and should presumably now be included within the area of the Australian mandate. But these are all minor points which do not affect the general usefulness of this well-printed map. It is accompanied by a sixteen-page pamphlet of statistical matter.

Elementary Principles of Continuous-Current Armature Winding. By F. M. Denton. (Pitman's Technical Primers.) Pp. x + 102. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

THE greater part of this compact little treatise has appeared in the columns of a contemporary. The principles governing the arrangement and proportioning of armature windings are worked out by a simple progressive treatment with very little mathematics, and some useful rules and comparative data are given.

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.*]

Propagation of Waves in an Isotropic Solid.

THE velocity of waves in an isotropic solid is proportional to the square root of the coefficient of that kind of elasticity called into action by the displacements which constitute the wave-motion. These displacements may involve either the simple rigidity (n), the volume elasticity (κ), or more generally a combination of both. The effective elasticity will depend partly on the nature of the initial disturbance, and partly on the boundary conditions

If torsional vibrations are propagated along a rod, the wave-velocity varies as $\sqrt{n}$; or if the pressure over the whole surface of a solid sphere varies simultaneously, a wave travels inwards with a velocity proportional to $\sqrt{\kappa}$. If the wave-length is great compared to the radius of the sphere, the latter is merely compressed and dilated as a whole; on the other hand, when wave-length/radius is small, the amplitude of the vibration increases as the wave travels inwards on account of the same energy being embodied in a shell of smaller mass.

At the centre of the sphere, if the limits of elasticity did not operate, the amplitude would be infinite, but in any real case disruption of some sort would occur.

Analogies may be found in other cases where a constant energy content is confined in a continually decreasing mass, as, for instance, in the "cracking" of a whip, or in the drop thrown up in the centre of a circular basin of fluid after a small wave has been initiated round the circumference.

When longitudinal waves are propagated along a rod of which the transverse dimension (A) is small compared to the wave-length (λ), the velocity is proportional to $\sqrt{\text{Young's modulus}}$ (E), which contains both n and κ.

Such longitudinal waves always occasion lateral motions of the particles proportional to Poisson's ratio (μ) for the substance, but these are of little importance as long as λ/A is great. If, however, A/λ is great, the lateral motion at the surface of the rod might, if the elasticity were still represented by Young's modulus, become greater than the longitudinal amplitude of the original wave; in fact, the two amplitudes would be equal when $A/\lambda = \mu$.

In reality, however, the surface deformation which must accompany the longitudinal wave exerts a normal force on the interior parts, and thus reduces the lateral motion to a quantity which decreases exponentially from the surface inwards.

The conditions for the elasticity defined by Young's modulus are that the deformations shall produce no normal force at the free surface, while for the elasticity which governs the same class of displacements in the far interior the conditions are that there shall be no normal motion.

If a force P parallel to Z acts on a unit cube and causes a contraction, α, then if no forces act parallel to x and y there is a lateral extension $\mu\alpha$ in both directions. If now keeping the stress P constant, a force $E\mu\alpha$ is caused to act parallel to x and y, the lateral dimensions are restored to their constrained magnitude, and the longitudinal strain is decreased by $2\mu^2\alpha$. Thus if the coefficient of the interior elasticity is denoted by B, $B(1-2\mu^2)=E$, or $B=E/1-2\mu^2$.

The expression for E in terms of n and κ is $9n\kappa/3\kappa+n$ and for μ, $3\kappa-2n/2(3\kappa+n)$. In Fig. 1 curves are given showing the values of E and B as multiples of n in terms of μ. At the surface of a solid the wave-velocity is always proportional to $\sqrt{E}$, but gradually increases to $\sqrt{B}$ in the interior. Assuming that the lateral displacements vary as $e^{-\frac{y}{c}}$ (y normal to the free surface), it will be found that when λ/A is great $c=\frac{\lambda}{2\pi}\frac{E}{n}$.

Thus at the depth of one wave-length the coefficient of elasticity nearly approaches B. If a plane wave surface starts from OY (Fig. 2) in the direction of Z, its surface will, as it progresses, assume the form sketched at Z_1Y_1. Earthquake waves must be affected by the change from B in the interior to E at the surface, and if a plane wave of compression were vertical at its source it would afterwards cut the surface at a more or less acute angle.

In iron or glass $\sqrt{B} > \sqrt{E}$ by something like 10 per cent., and it would be interesting to examine the velocity of very short waves in rods of such materials.

The chief experimental difficulty would be to originate waves the length of which was only a small fraction of the diameters of the rods.

Since compression at the surface of a solid depends on E, it would be just possible for a precipice to exist where the height and density of the material made the pressure at the base equal to the "crushing" limit. Taking this limit from some of the text-

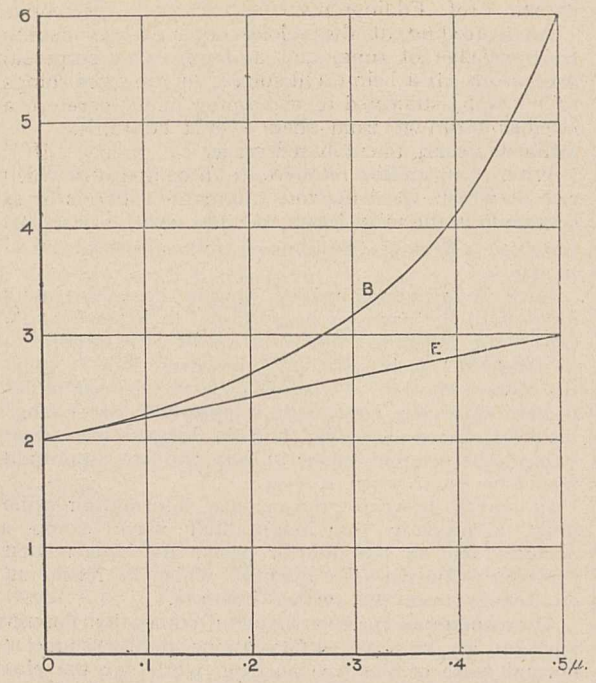

FIG. 1.—The ordinates of the curves show respectively the values of the coefficients E and B as multiples of the rigidity (n) in terms of Poisson's ratio (μ).

books on the "strengths of materials," it appears that the highest vertical face which could stand is, for granite, marble, or gneiss, 8000–14,000 ft.; various limestones, 5000–9000 ft.; various sandstones, 2500–9000 ft.; and various chalks, 500–2500 ft.

I believe that no real precipice (*i.e.* vertical wall of rock) is known which exceeds, even if it reaches, a height of 6000 ft., nor is it to be expected that

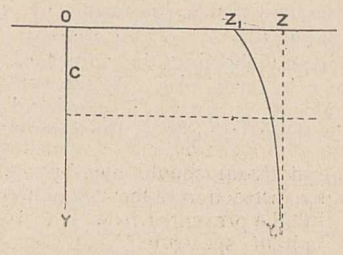

FIG. 2.—OZ is the surface of the ground; OV indicates a vertical plane wave surface; Z_1Y_1 indicates the same surface after advancing in the direction OZ.

weathering and other influences would allow of anything like the maximum crushing stress to be borne permanently at a free face.

If a solid were compressed by a piston in a perfectly inextensible cylinder, the strain produced would not be simple volume compression, but volume compression combined with a certain amount of shear, and if the shearing strain exceeds the shear limit, some molecular rearrangement must take place, although the boundary conditions prevent any actual rupture. The very large differences in the densities of various chalks and limestones may, perhaps, be indications of the pressures to which they have been subjected after their deposition.

A. MALLOCK.

9 Baring Crescent, Exeter, November 11.

The Action of Sunlight: A Case for Inquiry.

RECENTLY the *Times* published an article by Prof. Benjamin Moore on the action of sunlight, and the ensuing correspondence revealed an extreme contrariety of opinion upon a subject of primary and profound biological and civic importance. Upon such a question men of science should surely have reached some agreement, but it is not so.

Even amongst those who are certain of the superlative powers of sunlight against certain forms of disease, which I have called the diseases of darkness, there is extreme contradiction of opinion as to its *modus operandi*, and this is not merely an academic question, but vitally concerns our urban lives. For about thirty years it has been believed that the healing power of sunlight resides in its ultra-violet rays, which are not light at all in the visible sense. If that be true, it is so much the worse for us in London or Glasgow or Liverpool or Belfast, who are near sea-level, where the solar radiation is very poor indeed in those rays.

I have lately seen the work of Dr. Rollier at Leysin, in the Alps, where ultra-violet rays abound. Since then I have seen for myself the work, second only to his, of the Treloar Hospital, under Sir Henry Gauvain, at Hayling Island, on the English Channel. The view of Prof. Benjamin Moore and Dr. Leonard Hill that the ultra-violet rays are not useful, but dangerous, needing exclusion by the development of pigment in the skin, is thus supported. In a recent letter to a contemporary, *à propos* an article of mine on this subject, Prof. W. M. Bayliss has further questioned the value of the ultra-violet rays, and has pointed to the need for an inquiry.

It is clearly all-important for us to know whether our ordinary English sun, "the light of common day," provides us, at our customary humble levels of business, with enough of the very kinds of radiation which avail for life and against death. I believe that it does, and my belief is strongly confirmed by the reading of the recent papers by Dr. Carl Sonne, of the Finsen Light Institute, at Copenhagen, according to which the healing power of sunlight is due to its familiar, visible rays.

We expect at any moment the final report of Lord Newton's Committee on Smoke Abatement. It will, I am confident, be a cogent and valuable document. Already the time has come, predicted by Dr. Hill a few weeks ago, when we should be longing for the sunlight—and the wise and well-to-do are following the advice of railway advertisements to "Escape Winter Fogs" by going to Monte Carlo. They are, however, "statistically contemptible." The mass of the population, upon whom our Empire chiefly depends in peace and war, have to winter "very otherwise"—here, at least, but not, say, in Winnipeg or Calgary, as I learnt there recently.

Following the publication of Lord Newton's report, let us have a co-ordinated inquiry into the action of sunlight in health and disease, under the fortunate auspices, to which already we owe so much, of the Medical Research Council and Sir Walter Fletcher,

its secretary. For so wide a theme we shall need the physicist and chemist and biochemist and physiologist and tuberculosis expert and sanitarian, at least.

In the upshot it will appear, I believe, that "the things men live by" (and for lack of which they die), even in our complex and marvellous cities, are very simple. The primary laws remain. As Bacon said, "Nature can be commanded only by obeying her." For the body we need little more than light and air and water and fresh food—*pâté de foie gras* and *eau de Cologne* and champagne are superfluities; and for the soul, as Dr. Cabot, of Boston, says, we need no more (nor less) than work and play and love and worship.

C. W. SALEEBY.

Royal Institution, November 26.

Relativity and Materialism.

MY reply to my friend Mr. Hugh Elliot is quite plainly that, so far as I can discover from his letter in NATURE of December 1, and from his book, and from an article I have read of his, and from an essay which I believe nearly won the five-thousand-dollar prize, he has not understood the principle of relativity. He discusses with very great ability and lucidity the negative results of the experiments and all the illustrations of conflicting experience in relatively moving systems of reference, and, for aught I know, he may be quite familiar with the differential equations which the relativist mathematicians use, but all that he does is to offer a plausible explanation of the phenomena on his materialistic hypothesis. That is not the principle of relativity, yet, strangely enough, he seems quite convinced that it is. The principle of relativity is essentially the construction of the universe from pure concrete experience without any causal theory of experience whatever. This is the very antithesis of materialism. To affirm the contrary is like saying that Berkeley is a materialist. It is simply evidence that words are being used without knowing their meaning.

But let me bring the matter to the test. The universe, according to Minkowski, Einstein, and the other relativists, is a four-dimensional continuum. In this universe there is no simultaneity. This does not mean that we have to calculate the simultaneity of events on a new principle; it means that simultaneity in the accepted meaning has lost all significance, and, in fact, represents nothing; no two events are simultaneous in any absolute or universal meaning. Also in this universe there is no universal system of geometry, nothing which even takes the place of the Euclidean geometry of the Newtonian absolute space. Every point-event has its own geometrical system. The whole rationality of these concepts lies in the conception of a scientific reality constituted wholly of concrete experience. Hence every point-instant in this universe the track of which forms a world-line is taken primarily from its own point of view, according to which it is central and its direction straight.

How can anyone accept this basis of scientific reality and be a materialist? Materialism is a metaphysical theory which may be right, and relativity is an anti-metaphysical theory which may be wrong, but acceptance of the one is the rejection of the other.

H. WILDON CARR.

King's College, London, December 2.

PROF. TYNDALL, in his "Scientific Use of the Imagination," allowed a fair play-room to this faculty in scientific research. Dr. Norman Campbell would seemingly restrict its use to a sphere in which phenomena could be submitted to the check of experiment. In his letter in NATURE of November 24, and in his contribution to the Einstein controversy in the issue of February 17 of the present year, he demurs to the use of arguments based on anything that cannot possibly happen.

Dr. Campbell would thus rule out, as scientifically invalid, Prof. Eddington's conception of a perceptive being, travelling at the velocity of light, as having no knowledge of time, and as living in a perpetual present. Such a being and such a condition of things could not be subjected to experiment, and therefore a conclusion drawn from them would be futile.

Einstein's argument based on an imaginary "lift" hanging in space far removed from matter, in which an observer draws deductions, from his experience, as to his gravitational field, would also come under Dr. Campbell's censure, as being outside the region of experiment.

Dr. Campbell seems to me—but I may be quite wrong—to lay down a new canon of scientific method.

EDMUND MCCLURE.

80 Eccleston Square, S.W.1, November 28.

The Radiant Spectrum.

PROF. RAMAN has recently directed attention (NATURE, September 1, p. 12) to some observations by Brewster on what the latter called the "radiant spectrum" (*Phil. Mag.*, vol. 2, p. 202, 1867). Brewster advanced the hypothesis that the phenomenon was due to the granular surfaces of the eye rendering the ultra-violet rays visible by fluorescence. Prof. Raman proposes the alternative hypothesis that diffraction by the corneal corpuscles of the eye accounts for the phenomenon. Brewster's view is at variance with the fact that when a colour screen, opaque to ultra-violet rays, is placed in the optical path between the source, the prism, and the eye, it does not render the "radiant spectrum" appreciably less visible. Fluorescence set up by ultra-violet rays can therefore be safely excluded as a possible cause of the phenomenon. Prof. Raman's view that diffraction effects by the corneal corpuscles of the eye are responsible is at variance with the following facts:—

(1) That if the head of the observer be rotated, so as to rotate the eye about its optical axis, and therefore cause the corneal corpuscles to take up new meridians, then little or no change, such as might be expected, is seen to occur in the radiant spectrum.

(2) That by placing a suitable screen between the prism and the eye, it is possible to exclude the ordinary direct spectrum of the light source and yet still to observe the so-called "radiant spectrum." If the effect was produced by the eye, such a cutting off of the direct spectrum should also have the effect of destroying any diffraction effects produced, since all light would thus be prevented from reaching the eye.

(3) The "radiant spectrum" can be seen on the ground glass of a photographic camera, and can presumably, therefore, be photographed. Since no corneal corpuscles are present in a glass lens the "radiant spectrum" should not, on Raman's hypothesis, be visible in this case.

The following hypothesis fits in with all the above facts, viz. that the "radiant spectrum" originates by diffraction principally at the prism surfaces themselves. Four observations are in favour of this view:—

(1) That a prism with very perfectly polished sides gives a very weak radiant spectrum.

(2) That if the surfaces of such a prism be covered with finger marks, the radiant spectrum becomes very much more intense.

(3) That a prism with very scratched or poorly polished surfaces gives an intense radiant spectrum.

(4) But if now the surfaces be oiled to obliterate the scratches the radiant spectrum is much diminished in visibility.

If the surfaces of the prism itself are responsible, as the above evidence would seem to show, the question arises: Why should the radiant spectrum always appear to have its achromatic centre at apparently a fixed position in the ultra-violet part of the ordinary spectrum of the source?

The following explanation may be advanced: When light passes through an optical surface which is marred by random imperfections, a portion of the light is lost in the formation of a vast number of impure spectra of various dispersions, orders, and meridians, which are oriented about the centre formed by the image of the source.

In all these spectra the short wave-length rays are less deviated, and therefore appear closer to the source, than do the rays of longer wave-length, which shows that the spectra are produced by diffraction and not by refraction.

It will be observed further that the spectra are arranged according to their length, short spectra being nearest to the source, long spectra farthest from it.

If now this congeries of scratch spectra be looked

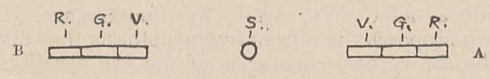

FIG. 1.—"Radiant spectrum" before refraction.

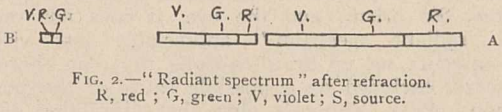

FIG. 2.—"Radiant spectrum" after refraction.
R, red; G, green; V, violet; S, source.

at by an observer through a prism, the position of the colours in the scratch spectra will be altered: on one side of the source the scratch spectra will be still further dispersed since the dispersion of rays of different length already produced by diffraction is added to by the dispersion of the prism, as shown at A in Figs. 1 and 2, while on the other side they will be less dispersed, as shown at B, because the dispersion produced by the prism is in the opposite direction to that produced by diffraction. But since the scratch spectra vary in length according to their angular distance from the source, there will be in a certain position a scratch spectrum the dispersion of which is equal in length but the opposite way round to that of the prism through which the scratch spectra are being observed; the rays in this spectrum will thus be recombined to form white light, and this will form the achromatic centre of the apparent "radiant spectrum." The other scratch spectra will from similar reasoning rearrange themselves in order about the achromatic centre according to their length.

It should follow from this that the achromatic centre should always be beyond the violet end of the spectrum of the source by a distance roughly equal to the length of the spectrum of the source itself. That is, that the displacement of the achromatic centre should vary with the dispersion of the prism and not with its deviation. Experiment shows that this is the case. This explanation obviously covers the case where the optical surface setting up "scratch" spectra is that face of the prism which is situated farther from the observer. With regard to the near face, it will be seen that the final image presented to the eye is the same, whether diffraction effects produced by the imperfections of an optical surface are afterwards refracted by a prism, or whether the prism first produces the refraction spectrum, which is, in its turn, diffracted, so long as parallel rays are used to illuminate the two systems. But a small bright source situated some distance from the eye produces approximately parallel light, and therefore, if the path difference of optical surface and prism is small, the same effect will be produced whichever is placed nearer the eye.

The hypothesis that the "radiant spectrum" is produced by diffraction due to imperfections in the prism surfaces, therefore, fits in with all the observations that I have been able to make. But it does not exclude the possibility that the optical surfaces of the eye add their effects to those produced by the prism surfaces. Experiment shows, however, that they are very slight, which points to the surfaces of the cornea and crystalline lens being very free from irregularities.

It remains to consider Brewster's final observations on the "radiant spectrum." He found that the centre of the figure was closer to the direct spectrum by red light, and farther from it with blue light than it was with green or yellow light. These facts can be readily explained if the differences in the relative dispersion of the rays in the cases of prismatic and diffraction spectra be considered. Since the red rays in the prismatic spectrum suffer small relative dispersions, short scratch spectra close to the image of the source will be overfolded, and the centre of the figure will therefore be close to the direct spectrum. Since blue and violet rays in the prismatic spectrum suffer large relative dispersions long scratch spectra far from the image of the source will be overfolded, and the centre of the figure will therefore be some distance from the direct spectrum. By green and yellow rays, which suffer medium relative dispersion, the centre of the figure should be a medium distance from the direct spectrum, as Brewster found was the case.

H. HARTRIDGE.

King's College, Cambridge.

Microscope Illumination and Fatigue.

I WAS much interested in the letter from Mr. H. J. Denham on the above subject in NATURE of November 17. It is gratifying to know that the importance of adjustment of the intensity of illumination in the microscope is recognised. At the National Institute for Medical Research several workers are provided with appliances for modifying this intensity, and they are agreed that it increases their comfort and efficiency. But I am in disagreement with the method that Mr. Denham adopts. The subject is too lengthy to discuss in full, but it is, I think, an accepted principle that the dominant wave-length in any light used for the microscope should be as short as possible, and that any light-modifier should reduce intensity without any alteration of quality. It is also well known that the wave-length of the dominant radiation is inversely proportional to the absolute temperature of the radiating substance, which in the case of the "Pointolite" lamp is tungsten. To alter the intensity of such an illuminant, therefore, by means of a resistance results in such an alteration of quality that the light

becomes useless for exact work, and we long ago tried and discarded such a method for this reason.

A method that does not possess this disadvantage is to use partially platinised glass screens. These can easily be made by methods already known, and the effect on any illuminant is to reduce its intensity without changing its character. In my own practice I have a number of these, the absorption of which has been tested by a photometer, mounted in a small frame so that they can in a moment be passed along in the path of the beam. The process is, in fact, less troublesome than operating a sliding resistance. The light can therefore be reduced by a known amount at each step. The advantage of this when a change is made, say from a low power ocular to a high one, is obvious. The relative light-transmitting power of the oculars is known, and it is, therefore, only necessary to move a suitable screen into position in each case when the intensity of illumination in the field of view is the same for both. Should a gradual change of intensity be required, then an arrangement recently placed on the market by Messrs. R. and J. Beck, Ltd., will do all that is necessary. It consists of two graduated neutral wedges which are moved across one another by a simple gearing so that any degree of opacity may be obtained and the light controlled between wide limits. J. E. BARNARD.

National Institute for Medical Research,
Hampstead, London, N.W.3, November 29.

Hybridity and the Evolution of Species.

DR. J. P. LOTSY, in his letter to NATURE of November 24, asks zoologists to answer the question: Is there any evidence that the presence of oligopyrene and apyrene sperms in some insects and molluscs is due to hybridity?

In the first place the atypic sperms of molluscs are not of the same nature as those of moths, for in the case of moths the appearance of atypicality is during the maturation stages. The spermatocyte which will give rise to the atypic sperms has not yet been distinguished cytologically from one which will give rise to normal sperms.

So far as the atypic sperms of prosobranch mollusca are concerned, quite a different condition holds good. Some years ago it was shown (Quart. Jour. Micr. Science, vol. 63, p. 421) that apart from the then known fact that the atypic and typic spermatocytes were cytologically distinguishable, it was possible to trace back these two sorts of cells to two different kinds of germinal epithelial cells. In the primary spermatogonium of the atypic series, the mitochondria were granular, while those of the typic series were sausage- or rod-shaped—a difference which I showed to hold good through growth stages and maturation divisions. It seems clear that the atypicality of the sperms of some molluscs is a quality deep-seated in certain germ-cells, while that of some moth sperms is possibly merely traceable to abnormalities in metabolism due to the rapidly changing conditions during histogenesis.

Now with regard to Dr. Lotsy's query as to whether the atypicality of mollusc sperms is evidence as to hybrid ancestry, it may be mentioned that in Pulmonata Mollusca, the mitochondria are always granular in the spermatocytes, while the atypic spermatocytes of prosobranch Mollusca alone are granular, while those of the typic are sausage-shaped.

I leave an interpretation of this important fact to Dr. Lotsy or his opponents. One more word—these differences in the mitochondria of the two kinds of spermatocytes of Paludina can be seen *intra vitam* in freshly teased out cells.

J. BRONTË GATENBY.

University of Dublin, November 26.

A Simple Micro-barograph.

READERS of NATURE may be interested in a simple form of differential barometer by means of which changes in air pressure as small as one part in a hundred thousand may be readily observed. The apparatus consists of a vacuum flask to the mouth of which is fitted a two-holed cork. One hole bears a capillary tube and the other a small tube provided with a tap.

A small drop of liquid is introduced into the capillary, and with the tap B open, it can be made to occupy any desired initial position. Tap B is now closed, and the movements of the drop A following

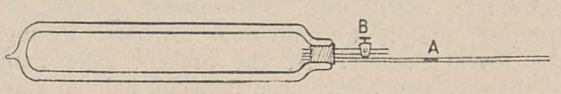

FIG. 1.

the changes in volume of the enclosed gas will indicate very small changes of pressure. The capillary, of course, must be kept level during the observations.

Using a vacuum flask of capacity 450 c.c., a capillary of 0·3 sq. mm. cross-section, and a drop of light paraffin oil as the liquid, the writer was able to demonstrate the changes of atmospheric pressure which occur during a change of vertical height of 1 ft.

The instrument was primarily designed for the purpose of demonstrating change of atmospheric pressure with height, and should be of use to teachers to demonstrate this phenomenon.

It would be interesting to know whether such an instrument has other applications. It may prove of interest to meteorologists for observing minute changes of atmospheric pressure during small time-intervals, and possibly also to aviators if set up in a less sensitive form. A. WECHSLER.

Hackney Technical Institute, London.

Scientific Workers in Russia.

MANY British scientific workers have acquaintances and friends among Russian men of science, and as Christmas is approaching they may wish to send a Christmas greeting which will support their colleagues during the hardest time that Russian science has ever had to endure. The American Relief Administration (67 Eaton Square, London, S.W.1) receives contributions in money, and from its famine relief stores in Russia will guarantee to deliver a parcel of foodstuffs to any person designated and will forward a receipt from the latter.

If a difficulty is found in selecting a particular Russian scientific worker, the parcel may be addressed simply to the Rector of the University of the city in question or to the President of the Military Medical Academy at Petrograd or the Academy of Sciences for distribution among the men of science of the respective institutions.

If necessary I can furnish information about a number of Russian scientific workers.

V. KORENCHEVSKY.

Lister Institute of Preventive Medicine,
Chelsea, London, S.W.1.

The Maintenance of Scientific Research.[1]

By PROF. C. S. SHERRINGTON, Pres.R.S.

BROADLY taken, the apparatus of prosecution of research in this country is made up as follows: (1) Scientific and professional societies and some institutions entirely privately supported; (2) universities and colleges, with their scientific departments; (3) institutions, using that term in the widest sense, directly subventioned by the State, such for instance as the Medical Research Council, the Development Commission, and the Department of Scientific and Industrial Research. Of these three categories, the first named, the scientific societies group, works without financial aid from the State, apart from the small though extremely useful two Government grants distributed, mainly to individual workers, through the Royal Society. At the present time many of the societies sorely need financial help to carry on their labours, and some are absolutely at a loss to know how to publish the scientific results that are brought to them. The second category, the universities and colleges, depends in part upon Government aid. In the aggregate of twenty-one institutions of university rank, following Vice-Chancellor Adami's figures, students' fees and endowment provide about 63·5 per cent. of the total income; for the rest they are dependent on Government grant. The third category, as said, draws State-support direct.

This triple system may seem a somewhat haphazard and inco-ordinate assembly. Yet in reality it is an organisation with much solidarity, and its co-ordination is becoming more assured. Its parts dovetail together. The first group, the scientific and professional societies, is provided with a medium of intercommunication and co-action, the Conjoint Board of Scientific Societies. As to the separate categories composing the triple system itself, they also are in wide touch one with another. Between the scientific and professional societies on one hand and the universities on the other, contact and inter-relation are secured by some degree of free and rightful overlap, both as regards general subject-matter of research and of their *personnel*. Finally, there is excellent contact between both these categories and the third, the State subventioned institutions. A special feature of the policy and administration of these State organisations secures this, a feature which makes the whole of this subject the more cognate to the purview of our own Society. To exemplify I may turn, for instance, to the Development Commission. Its programme of fishery research, avoiding the terms "pure" research and "applied" research in view of the possible implication that pure research does not lead to practical result, directs research not alone to the solving of particular economic problems. It supports more especially what it terms "free" research, investigation in this case of the fundamental science of the sea and of marine life.

Again, with the Advisory Council of Scientific and Industrial Research, its programme, gradually defined during the past six years, is laid down as having four main points: (1) the encouragement of the individual research worker, particularly in pure science; (2) the organisation of national industries into co-operative research associations; (3) the direction and co-ordination of research for national purposes; and (4) the aiding of suitable researches undertaken by scientific and professional societies and organisations. It recruits researchers by giving financial opportunity to promising students to be trained in research, attaching them to experienced researchers. In short, it apprentices to research a number of selected younger workers in universities, colleges, and other institutions scattered throughout the country.

So, similarly, the Medical Research Council. Its secretary, Sir Walter Fletcher, in an illuminating presidential address to Section I of the British Association meeting this summer, said, speaking of the nexus between scientific research and the progress of medicine, "It is the accumulating knowledge of the basal laws of life and of the living organism to which alone we can look for the sure establishment either of the study of disease or of the applied sciences of medicine."

It is evident, therefore, that, with a policy based on such principles as these, the third category in the triple system constituting the organisation for scientific research in this country is one which has common aim and solid touch with both the others, the universities and the scientific and professional societies. One sees in short that the organisation which has come into existence and is maintaining scientific research in this country is a real organisation. It did not spring fully equipped from the head of Zeus. It has grown up rather than been planned. In that respect it is an organisation essentially British, and it seems qualified to do its work for the country well. We hear of adventures, political and other, the offspring of the day. But these were no adventures, these, to my mind, welcome, long-overdue steps forward by the State toward the succour of science and its welfare, steps that help to strengthen and consolidate the organisation for research by such adjuncts as the Medical Research Council and the Department of Scientific and Industrial Research. One of the strengths of this organisation that has arisen is, in my view, that it interlocks with the educational system of the country. It is an organisation which proceeds on the wise premiss that, in the case of science, the best way to get the fruit is to cultivate the tree. It is an organisation which is

[1] From the presidential address delivered to the Royal Society at the anniversary meeting on November 30.

proving successful and economical. Its output has proved a more than liberal return on the funds at its disposal.

But essential to its continuance is continuance of adequate financial support from the Government. A tripod cannot stand upon two legs. The State-contribution in this country is relatively not large, but it is most important. Important as it has been in the past, it has now an importance most especially great. The cost of investigation is now higher, much higher than it has been. Endowment funds carry less far than they did carry. Private benefactions and voluntary generosity, although willing, are less able to be found and less capable at this time; already gauged as inadequate of themselves alone before the war, they obviously cannot alone cope with the necessary undertakings now. The present is a time when a large-scale withdrawal of the Government's financial support must prove most formidably crippling. Such crippling will be greater than the actual measure of the sum withdrawn would entail in ordinary times.

To pull down under emergency what has been built up through years of careful experience and is proving efficient can scarcely be ultimate economy. It is to unlearn a useful lesson learnt. Curtailment of the State aid—relatively small in this country—given to scientific research must harm the scientific production of the country. Some curtailment, however, at this time seems unavoidable. Though extension of buildings and equipment and *personnel* is wanted, it may be necessary to withhold that extension at this time, maintaining broadly the *status quo* ready for expansion when that is once more feasible. But if research be an indispensable factor in the rebuilding of the national life, sacrifices should not be required from it disproportionately greater than from other services of a similarly essential kind. Reduction of the State's support on a scale to entail ruin to the existent organisation would be a wastage rather than an economy. Calmly viewed, what more reminiscent of the wastage of the war itself than for machinery actually constructed, assembled, and producing what is needful for a nation's strength as a pillar in the industrial and intellectual temple of the world, to be now under temporary change abandoned or broken up; and at a time when industry as a whole stands convinced of scientific research as a necessity for its recovery and well-being.

My hope would be that scientific research on its present maintenance will be considered part of the intellectual bread of the community, part of the bed-rock on which rests the efficiency, not to speak of the industrial equipment, of the nation; that it will be treated as such in the measure of State-support continued to it; that the State will remember that that support has to embrace at least both the universities on one hand, and, on the other, the research institutions administered by the State, for this reason, namely, that the country's organisation for research, complex in origin, yet economical and effective, stands as an integral system to the entire existence of which is essential an adequate State provision for both these constituent elements, indispensable, since they are, to the whole structure of the system.

The Rayleigh Memorial.

The Unveiling in Westminster Abbey.

THE history of the Rayleigh Memorial is soon told. Shortly after Lord Rayleigh's death in 1919 the desire was expressed by many of his friends to commemorate him in some suitable manner, and a committee was formed, with Sir J. J. Thomson, then president of the Royal Society, as chairman, to give effect to this wish. The committee contained representatives of the University of Cambridge, of which Lord Rayleigh was chancellor, as well as of the Royal Society.

After consideration it was decided that, subject to the permission of dean and chapter, a memorial tablet should be placed in Westminster Abbey, while his work at Cambridge as Cavendish professor should be commemorated by the promotion of research in some branch of science in which he was interested.

The dean and chapter gave a cordial assent to the wishes of the committee, and a position was chosen for the tablet on the north wall of the north transept close to the memorials to Sir Humphry Davy and Dr. Thomas Young. No space could be found near the group of medallions described in Commander E. C. Smith's interesting article in NATURE of December 1 which form the memorials to Adams, Stokes, Hooker, Wallace, Darwin, Lister, and Joule, but Lord Rayleigh's work had close connection with that of both Young and Davy; much of it was a distinct outcome of the researches of Young, and the position selected is most suitable.

Lord Rayleigh's friends are greatly indebted to Prof. Derwent Wood, R.A., for the tablet shown in the accompanying illustration and especially for the very excellent likeness of Lord Rayleigh, their "unerring leader in the advancement of natural knowledge," which he has executed.

The ceremony on November 30 was a very simple one. A number of Lord Rayleigh's relatives and friends assembled in the Abbey and were met by the dean and Canon Barnes. After two short prayers the dean invited Sir Joseph Thomson, the chairman of the committee, to unveil the tablet. When this was done the memorial was dedicated by the dean and, as a tribute to Lord Rayleigh's work and position, an address, which is subjoined, was delivered by Sir Joseph. The ceremony was then closed with the Benediction.

The following members of Lord Rayleigh's family and representatives of the University of Cambridge, the council of the Royal Society and other institutions with which he was connected were among those who were present:—

The Dowager Lady Rayleigh, Lord and Lady Rayleigh, Mrs. Sidgwick, the Hon. R. Strutt, the Hon. Edward and Mrs. Strutt, the Rt. Hon. G. W. and Lady Betty Balfour, and Mr. E. J. Strutt; the vice-chancellor of the University of Cambridge, Sir Joseph Larmor, and Mr. J. F. P. Rawlinson, Members of Parliament for the university; the president of the Royal Society, Sir J. J. Thomson, Sir David Prain, Mr. W. B. Hardy, Mr. Jeans, Sir Arthur Schuster, Prof. Lamb, Sir William Bragg, Prof. Fowler, Prof. O. W. Richardson, Sir Gerald Lenox Conyngham, members of council of the Royal Society; and Prof. F. Derwent Wood, Lord Southborough, Sir James Dewar, Sir William McCormick, Sir Charles Parsons, Sir George Beilby, Sir Oliver Lodge, Sir Maurice Fitzmaurice, Sir Napier Shaw, and Sir Richard Glazebrook.

Photo] [*F. Hilaire d'Arcis*

Memorial tablet of Lord Rayleigh by Prof. Derwent Wood R.A., unveiled in Westminster Abbey on November 30.

In order to promote research in a branch of science in which Lord Rayleigh was interested, it has been arranged to hand over the balance of the fund, some 500*l.* in amount, to the University of Cambridge to be used as a library fund at the Cavendish Laboratory, where there is a research library to the formation of which Lord Rayleigh contributed when professor. To have an annual sum available for the purchase of periodicals, binding, etc., would, in the opinion of both Sir J. J. Thomson and Sir Ernest Rutherford be of real service and would greatly promote research in physics at Cambridge.

Sir Joseph Thomson's Address.

On behalf of the Royal Society and of the University of Cambridge it is my privilege to thank the Dean and Chapter of Westminster for permission to erect a memorial to Lord Rayleigh in the Abbey. I desire also to thank the artist, Mr. Derwent Wood, whose skill has made the memorial an excellent likeness of Lord Rayleigh, and has endowed it with artistic merits which make it worthy of a place on these walls. I desire also to thank the contributors whose generosity has made this memorial possible. I owe my position here this afternoon to the courtesy of the president of the Royal Society, and of the vice-chancellor of the University of Cambridge. Either of these would have been a more appropriate representative than myself, but it is their wish that, as chairman of the Committee of the Memorial, I should undertake this duty. It seems fitting that, on this occasion, when we place a memorial to Lord Rayleigh in a building surrounded by memorials of the most illustrious of Englishmen, a few words should be said as a tribute to his work and in support of his claim to be represented on these walls. Lord Rayleigh devoted a long life with entire singleness of purpose and pre-eminent success to the pursuit of what, in the phraseology of the Royal Society, is called "the promotion of natural knowledge." For fifty years, without pause and without hurry, he pursued researches which are one of the glories of English science. It is possible to form an estimate of the quality and quantity of Lord Rayleigh's work by those six volumes of collected papers which we owe to the enterprise of the Syndics of the Cambridge University Press. Among the 446 papers which fill these volumes there is not one that is trivial, there is not one that does not advance the subject with which it deals, there is not one that does not clear away difficulties; and among that great number there are scarcely any which time has shown to require correction. It is this, I think, which explains that while the collected papers of scientific men often form a kind of memorial tablet in our libraries, respected but not disturbed, those of Lord Rayleigh are among the most frequently consulted books in the physicist's library.

The first impression that we gain on looking at these volumes is the catholicity of Lord Rayleigh's work—mathematics, light, heat, electricity, magnetism, the properties of gases, of liquids and solids, are all represented in fairly equal proportions. If I were asked to explain in what department of physics Lord Rayleigh's work was most important I should be quite at a loss to do so. In these days when we speak of electricians, of molecular physicists, elasticians, or even if we take the wider classification

of mathematical physicists and experimental physicists, it is refreshing to come across one who was each—who, like Kelvin and Stokes, was each and all of these. Lord Rayleigh took physics for his province and extended the boundary of every department of physics. The impression made by reading his papers is not only due to the beauty of the new results attained, but to the clearness and insight displayed, which gives one a new grasp of the subject. No subject passed through Lord Rayleigh's mind without being clarified and having its difficulties either removed or brought so strongly into the light as to be subject to attack on every side.

The impression that one gets after reading a paper by Lord Rayleigh is that the subject, if I may use a homely phrase, has been tidied-up. Law and order have been substituted for disorder. There are some great men of science whose claim consists in having said the first word on a subject, in having introduced some new idea which has proved fruitful; there are others whose claim consists perhaps in having said the last word on the subject, and who have reduced the subject to logical consistency and clearness. I think by temperament Lord Rayleigh really belonged to the second group. Certainly no man ever revelled more in that greatest of intellectual pleasures, working at a subject which was all obscured and tangled and bringing it to a stage where everything was clear and in order. When we take Lord Rayleigh's papers we find some purely mathematical, in which, with his characteristic directness of attack and simplicity of means, he obtained most important results. We get others almost purely experimental, such as the determination of the absolute unit in electricity, in which, again, with simple apparatus, he attained results which rivalled in accuracy those of Regnault and Joule. But in the majority of writings we have a combination of mathematical analysis and experimental work, and his papers, I think, afford the best illustration of the true co-ordination of those two great branches of attack on the problems of nature. The physical ideas direct the mathematical analysis into the shortest and most appropriate channels, while the mathematics gives precision and point to the physics.

Just one word about another characteristic of Lord Rayleigh. He was, so to speak, the knight-errant of physics. There are men of whom it is said that they never shirk a difficulty, but Lord Rayleigh went roaming about seeking for difficulties to destroy, and I really believe that he loved a difficulty for its own sake, and perhaps felt sorry for it after he had destroyed it. But among the difficulties in physics none was ever created by any default of Lord Rayleigh in clearness of expression or clearness of thought. He was an artist in the production of his papers. He had the artist's instinct ingrained so deeply that even the excitement and hurry of the Cambridge Mathematical Tripos in the old days, when it was literally a race against time, could not destroy it. Every one of his examiners on that occasion said that his papers were so clear that they could have been sent to press without revision.

Among Lord Rayleigh's many discoveries I will just confine myself to one, the discovery of argon, because that is the one which attracted most attention, and in which, perhaps, he broke the newest ground. The discovery of argon is one of the romances of science. The fact was that we had, unsuspected among us, the element in large proportions—there are, I believe, some tons of it within the walls of this building—and yet, in spite of the experiments of chemists and physicists for centuries no suspicion of its existence had ever arisen. It seems rather an irony that while the chemists had been ransacking mines and searching the stars for new elements, all the time there had been in their laboratories an element with more remarkable properties than any that had been discovered. The remarkable thing about Lord Rayleigh's investigation was that it was not because he used instruments more powerful than any of those at the command of his predecessors. Argon was tracked down by the oldest piece of chemical apparatus, the balance, an instrument which had been at the command of all Lord Rayleigh's predecessors, and by which they might have made the discovery, but they did not. In the isolation of argon Lord Rayleigh was fortunate enough to procure the co-operation of Sir William Ramsay, and when the properties of the new substance were investigated they turned out to be of extraordinary interest, and the discovery of this, which was followed by the discovery of other gases of the same nature, has had a very pronounced influence on the progress of our ideas as to the structure of matter.

I must pass on from Lord Rayleigh's contributions to science to consider some of his public services. He was long and intimately connected with the Royal Society. For nine years he was secretary, and for three years he was president. He enriched the publications of that society by papers which added greatly to its prestige. He rendered great services to the University of Cambridge. On Maxwell's death in 1879, when the success of the new School of Physics was not yet assured, Lord Rayleigh, at considerable personal sacrifice, came to the rescue, and for five years he was the Cavendish Professor of Physics, and this work, with the assistance of that of Sir Richard Glazebrook and of Sir Napier Shaw, put the school on such a firm basis that its success has never since been in doubt. The University took the opportunity of honouring Lord Rayleigh by making him their chancellor; but it was not only work that Lord Rayleigh gave to the University: he was a generous benefactor. When he received the Nobel prize he handed over the money for the use of the University. Again, he was long connected with the Royal Institution. He was professor there for seventeen years, and many of us have heard those clear explanations of some of the most difficult problems of physics, accompanied by experiments, which were characteristically simple and beautiful.

But of all the bodies with which Lord Rayleigh was associated I doubt if there was one in which he was more interested than in the National Physical Laboratory. He was the chairman of the committee which recommended the foundation of that institution, and he was chairman of the executive body from the beginning until a year or two before his death. The growth of that institution from very small beginnings to the position it now occupies, that of the most important institution of its kind in the world, is due in no small degree to the work that Lord Rayleigh gave to it, to the judgment that he displayed in conducting its affairs, to his knowledge, and to his influence.

Another subject in connection with which Lord Rayleigh rendered great services was that of flight. He was convinced long before other people of the possibility, and even the probability, of flight, and when flight became a serious problem to this country he became chairman of the Committee on Research in Aeronautics, and it meant everything to that sub-

ject, perpetually perplexed with new problems, to have at its command the unerring judgment of Lord Rayleigh and his knowledge of theory and his keen instinct for practice. During the war, when any specially important or specially difficult point arose in connection with the application of science for the use of the Army or Navy, Lord Rayleigh was very often consulted, and never in vain. Lord Rayleigh, I believe, has had every honour that this country can bestow, and he deserves that place on the walls of the Abbey close by the memorials to Davy and to Young, for, like them, he increased the prestige of this country in science, and widened the bounds of our knowledge of nature.

International Physico-chemical Symbols.

By PROF. ALEX. FINDLAY.

IN the years prior to the war endeavours were made by various internationally constituted bodies to secure greater uniformity in the symbols used in different countries and by different writers to represent physical, physico-chemical, and electrotechnical quantities. As part of the general movement to this end the International Association of Chemical Societies, founded in 1911, set up a Commission for the Unification of Physico-chemical Symbols, and in 1913 this commission submitted to the council of the International Association of Chemical Societies a list of symbols for quantities especially of physico-chemical importance. At this point, however, the need was felt for co-ordinating the work of the commission with that of other bodies, and a small "working committee," consisting of Sir William Ramsay (chairman), Dr. Friedrich Auerbach, Profs. P. A. Guye, P. J. Walden, and Alex. Findlay (secretary), was therefore set up in order to secure this co-ordination and to suggest methods of organisation and work.

The list of symbols drawn up by the Commission for the Unification of Physico-chemical Symbols was submitted for consideration and criticism to the chemical societies of the different countries represented on the International Association, to the Ausschuss für Einheiten und Formelgrössen, and to the International Electrotechnical Commission. The criticisms and suggestions received from these bodies were considered in May, 1914, by the working committee to which reference has been made above, and a list of symbols was then drawn up for the approval of the International Commission. Unfortunately, however, before the meeting of the International Commission took place, international scientific relations were ruptured by the outbreak of war, and the list of symbols recommended unanimously by the members of the working committee could not, therefore, receive the approval of the parent commission. As it is not to be doubted that this approval would have been given, and as it would have been a misfortune if the labours of the committee on which Great Britain, France, Germany, Russia, and Switzerland were represented had been in vain, the council of the Chemical Society, with the approval of the recently constituted International Union of Pure and Applied Chemistry, authorised the publication of the committee's report and list of symbols in the Transactions of the Chemical Society, April, 1921.[1]

As regards the general principles adopted by the working committee it may be said that in drawing up its list the committee restricted itself to symbols for quantities of chemical or physico-chemical importance and approved the general principle adopted by the International Commission that Greek letters should be used as sparingly as possible. In respect of symbols for quantities used, especially in mathematics, physics, and the various branches of mathematics and physics, the committee restricted itself to *noting* the symbols which had been recommended or adopted by the scientific bodies specially interested in these quantities, and there were included in the committee's list only those symbols about which there was general agreement among the specially competent bodies. As it was not possible, in the case of symbols which are employed in different branches of pure and applied science, always to obtain agreement among the representatives of different sciences, the committee adopted the symbols which find, or are likely to find, general acceptance by chemists or physico-chemists.

Although a practically universal agreement already obtained regarding many of the symbols, there were a number of quantities for which diverse symbols were employed by different writers or were suggested by various bodies. It was necessary, therefore, for the committee to examine, carefully and critically, the different suggestions and to make a decision as to the symbols to be recommended for use. The reasons for the choice of symbol made by the committee in the debated cases are appended to the list of symbols.

Although it is not possible to refer specifically to all debatable cases, reference may be made to a few important quantities. For entropy and for maximum work the committee recommends the symbols S and A respectively, although in doing so regret is expressed at having to depart from the classical symbols ϕ and ψ employed by Willard Gibbs. The committee, however, states that it felt such departure to be advisable on the twofold principle of disturbing existing usage as little as possible and of employing Greek letters as sparingly as possible. For degree of dissociation

[1] Copies of the report and list of symbols may be obtained on application to the Assistant Secretary of the Chemical Society, Burlington House, London, W.1.

(ionic, thermal, etc.) the committee recommends the symbol α; for the ratio of specific heats the symbol γ; and for electrode potential, as for electromotive force, the symbol E. It may also be noted that the committee recommends that kation should always be spelt with a "k."

While the committee considered it to be inadvisable that any attempt should be made to compel authors to use the symbols which it recommends, it was of opinion that every means should be taken to encourage the use of these symbols, and it remains for the different official bodies concerned to consider how such encouragement can best be given.

Obituary.

DR. J. A. ALLEN.

MR. H. E. ANTHONY, associate curator of mammals in the American Museum of Natural History, New York, has sent us a detailed notice of the life and scientific work of DR. J. A. ALLEN. Lack of space prevents us from publishing more than the following extracts referring to a few points of particular interest:—

Natural history has suffered a heavy loss by the death, on August 29 last, of Dr. Joel Asaph Allen at eighty-three years of age. Dr. Allen was best known for the work in mammalogy which he carried out as curator of ornithology and mammalogy in the American Museum of Natural History of New York City. However, his activities were manifold, and an insight into the truly remarkable amount of work accomplished by Dr. Allen may be gained from a glance at his bibliography, which in 1916 included the following: Papers on mammals, 271; on birds, 966; on reptiles, 5; on zoogeography, 9; on evolution, 22; on nomenclature, 35; on biography, 134; miscellaneous, 20; a total of no less than 1462 papers. Since the publication of this list other papers have appeared and a great deal of unpublished manuscript has been prepared for publication. One could not but be impressed by such a list as a mere feat of writing alone, but the workers in his field who consult the publications of Dr. Allen know that an infinite amount of patience, of painstaking application to tiring detail, and of well-balanced and judicious weighing of facts, is characteristic of his papers.

The bulk of Dr. Allen's papers deal with taxonomic questions, with the identification of collections and with the revision of groups. Many of the latter have become classical, and among the best-known might be mentioned the monographs on North American Rodentia, written in collaboration with Dr. Elliot Coues. Dr. Allen had marked capabilities for philosophical research into, and interpretation of, the phenomena of zoology, as is well shown by some of his earlier papers, but circumstances directed that he should expend his energies in other directions.

One of his youthful aspirations was for editorial work, and from 1874, when he edited his first "Proceedings of the Boston Society of Natural History," until 1918 he performed continuous service as editor of several scientific publications. For thirty-two years of this period he edited the Bulletin of the American Museum of Natural History, and for twenty-eight years the *Auk*.

Probably Dr. Allen is best known internationally through his authoritative position on zoological nomenclature. In this exacting field he was pre-eminent; internationally his worth was recognised by his position on the International Commissions since 1910.

Among the many honours which Dr. Allen received may be mentioned the Walker Grand Prize of the Boston Society of Natural History in 1903, and the medal of the Linnæan Society of New York in 1916; he was president of the American Ornithologists' Union, 1883–91, president of the Linnæan Society of New York, 1890–1897, member of the National Academy of Sciences, etc. He was also an honorary member of the British Ornithologists' Union, the Zoological Society of London, the Australian Ornithologists' Union, and the South African Ornithologists' Union.

The early part of Dr. Allen's life was spent in New England. That part of his academic training which had most influence upon his later life was his association with the great teacher, Louis Agassiz. Struggling under the handicap of a constitution at no time very strong, he made several notable collecting trips, the most important being that to Brazil in 1865. His first museum appointment was with the Museum of Comparative Zoology at Cambridge, Massachusetts, but in 1885 he took a curatorship in the American Museum of Natural History of New York City. Here his tenure was continuous until the time of his death.

Dr. Allen numbered among his friends practically all the well-known workers on birds and mammals, and the respect for his scientific attainments promptly grew into a love of the man himself whenever one was fortunate enough to be numbered among his personal friends.

W. A. BAILLIE-GROHMAN.

IT is with much regret that we record the death of Mr. W. A. Baillie-Grohman, who passed away suddenly on November 27 at Schloss Matzen, in Tyrol, in his seventy-first year. A man of striking physique, endowed with high courage and great mind, he possessed an intense affection for the wild and grand in Nature, coupled, remarkably enough, with an unflagging interest in much that is purely scholarly. That such a man, the son of a sporting Austrian of large estate, should have developed in early youth what proved to be permanent tastes for hunting and mountaineering was perhaps inevitable, and in due course his adven-

tures upon the mountains of Europe and North America gained for him a great reputation both as an intrepid climber and as a shooter of big game. But his claim to be remembered by naturalists rests upon a far more secure foundation, for many who achieve distinction in the fields indicated are, perhaps, best forgotten.

Most fortunately, Baillie-Grohman soon began to write about his favourite pursuits, and from 1875 onwards many books and innumerable articles in periodicals flowed from his pen. In these writings there is much of interest and importance to the naturalist, for the author was keen-sighted as well as judicious. His love of the chase led him to examine everything connected with its history, and with the utmost patience and industry he explored ancient books, pictures, tapestries, and mouldering heaps of medieval records in search of facts. The results of these researches are well seen in what is probably Baillie-Grohman's greatest book, "Sport in Art" (1913), which is, in effect, an admirable history of the chase as practised in the four centuries between 1400 and 1800. Of even greater interest are his two editions of "The Master of Game," written by Edward, second Duke of York (Shakespeare's "false Aumerle"), between 1406 and 1413. This work, comprising a translation of Gaston de Foix's "Livre de Chasse" (*circa* 1390), and five original chapters on English hunting, is the oldest book of hunting in our language, and as such must always make a special appeal to the student of British mammals.

BY the death of MR. R. W. FRAZER, at sixty-seven years of age, India has lost a learned philologist and student of its literature and philosophy. Joining the Madras Civil Service in 1877, he was invalided in 1881 as the result of exposure on famine duties and service during a local disturbance in the Godavari Hills. On his retirement he became librarian of the London Institution, and it was by his initiative that it was absorbed by the School of Oriental Studies. Frazer lectured extensively on subjects connected with Southern India, and acquired a seldom-rivalled knowledge of Tamil and Telugu. He will be best remembered by his "British India" in the "Story of the Nations" series, his "Literary History of India," and "Indian Thought, Past and Present." He was for a short time secretary of the Royal Asiatic Society, succeeding Miss Hughes, who became his wife, and survives him.

Notes.

THE anniversary meeting of the Royal Society was held on St. Andrew's Day, November 30, and the following officers were elected:—*President:* Prof. C. S. Sherrington. *Treasurer:* Sir David Prain. *Secretaries:* Mr. W. B. Hardy and Mr. J. H. Jeans. *Foreign Secretary:* Sir Arthur Schuster. *Other Members of Council:* Sir Frederick Andrewes, Prof. V. H. Blackman, Sir William Bragg, Prof. A. W. Crossley, Dr. H. H. Dale, Prof. A. S. Eddington, Prof. A. Fowler, Prof. A. Harden, Prof. J. Graham Kerr, Prof. H. Lamb, Sir William Leishman, Sir Gerald Lenox Conyngham, Lord Rayleigh, Prof. O. W. Richardson, Sir Aubrey Strahan, and Prof. J. T. Wilson. Prof. Sherrington delivered the anniversary address, which is abridged on p. 470 of this issue, and presented the medals as follows:—The Copley Medal to Sir Joseph Larmor, who has long held a leading position in the British school of mathematical physics. It may fairly be said that his preliminary work was of the utmost value in paving the way to the modern developments of the theory of relativity. A Royal medal to Dr. Frederick Frost Blackman, distinguished for his contributions to plant physiology, and especially to knowledge of the process of photo-synthetic assimilation of carbon dioxide. A Royal medal to Sir Frank Dyson, who has devoted special attention to investigations of the movements and distances of the stars and of the bearing of these upon the structure of the stellar universe. It was mainly to his foresight and organising ability that we owe the successful observations of the deflection of light by the sun's gravitational field during the eclipse of 1919. The Davy medal to Prof. Phillipe Auguste Guye, in recognition of his work on optically active organic substances, on molecular association, and on atomic weights. The Hughes medal to Prof. Niels Bohr, the author of the conception to which the name "Bohr-atom" has been attached. This conception gave a solution of the long-standing puzzle of the Balmer series of hydrogen, and appears likely to provide a complete explanation of the spectra of the various elements.

AT the meeting of the Royal Geographical Society held on Monday, December 5, the president announced that it is hoped the members of the Mount Everest Expedition will have returned by the end of this week. Messrs. Raeburn and Mallory are already home, and Col. Howard Bury and Messrs. Wollaston and Bullock are on their way. The natural history collection and the photographic plates have also arrived, and the maps will be here within the next fortnight. It is satisfactory to find that the collections have reached home in excellent order. There is a plant belonging to the pink family from a height of 20,400 ft. above sea-level, and there are several kinds of primula—pale yellow, blue, and dark purple—and one with big hanging bells, and many gentians, a remarkable yellow *Pedicularis delphinium*, and some beautiful dwarf rhododendrons. One hundred and sixteen packets of seed in excellent condition are among the treasures which have reached the Royal Geographical Society, of which eighteen packets are of rhododendrons, twelve of primulas, eighteen of meconopsis, and four of gentians. From a height of 19,000 ft., the highest point from which seeds were obtained, is a packet of edelweiss. Then there is a sparrow from 18,500 ft.,

larks of various species, including a very large calandra lark which may perhaps be new, wagtails, white-headed robins, a chough and cuckoo, rose-finches, bullfinches, and—of fine omen—a blue bird. There are also boxes of birds' eggs, numerous butterflies and moths, and other insects, including bees and fleas, frogs and fishes, and a few mammals. These are all now at Kew and the Natural History Museum being identified and distributed. The photographic plates, all developed, have arrived without a single breakage, and the number of photographs the society now has is more than six hundred. A selection of the best will be exhibited to the public in the Alpine Club Gallery in the middle of January.

DR. NIELS BOHR (Copenhagen), Dr. Johan Hjort, head of the Norwegian Fisheries, and Prof. Paul Langevin (Paris) have been elected honorary members of the Royal Institution.

THE American Association for the Advancement of Science will meet in Toronto on December 27–31 in the University buildings. The Royal Astronomical Society of Canada will meet at the same time and assist in the programme of the Association.

THE Paris correspondent of the *Times* announces that M. Georges Claude, who has been awarded the Prix le Conte of 50,000 francs (1000*l*.) by the Academy of Sciences for his work in chemistry and physics and the practical application of the results to industry, has requested the Academy to devote one-half of the amount to the Société de Secours des Amis des Sciences and the other half to the research laboratories of the Collège de France.

PROF. HORACE LAMB, Sir Ernest Rutherford, Sir Arthur Schuster, and Prof. G. Elliot Smith have been elected honorary members of the Manchester Literary and Philosophical Society. Dr. H. F. Coward has been elected chairman of the chemical section of the society for the ensuing session.

A HIGHLY successful course of Swiney Lectures on Geology was completed on December 2 by Dr. J. D. Falconer at the Imperial College of Science, South Kensington. These lectures are delivered annually under the auspices of the trustees of the British Museum, and are designed to stimulate public interest in geological science. The average attendance for the twelve lectures was 261, a gratifying record to all concerned.

THE annual general meeting of the Decimal Association was held on November 30 at Stationers' Hall. Proposals for the adoption by the association of a step by step policy in dealing with weights and measures were made, and the following resolution was carried: "That this association, while adhering to the policy of adopting the metric system of weights and measures, recognises that its object can best be obtained in steps, and that the first step should be the dealing with weights."

THE Jamaica earthquake of January 14, 1907, so destructive to the city of Kingston, was followed by a number of after-shocks, of which nearly a hundred during the succeeding six months were strong enough to be registered in this country. Stronger than any of these after-shocks, or indeed than any earthquake in the island since 1907, was that which occurred on November 25 last. The shock was of short duration, but it was strong enough to crack the walls of some buildings.

UNDER the presidency of M. Millerand, President of the French Republic, a meeting was held at the Sorbonne, Paris, at 3 p.m. on November 24 to commemorate the centenary of Ampère's publication of his fundamental laws of electromagnetism. The President was supported by the chief Ministers of public Departments, and the Republican Guard under the direction of M. Balay played selections during the proceedings. Addresses were delivered by Prof. Berthelot, Appell, and Janet and by Messrs. Legouez, Boucherot, Mailloux, and Berard. During the following morning a reception took place at the Conservatoire des Arts et Métiers, and the new gallery of models of telegraphic and telephonic apparatus was opened. An Ampère medal is being struck as a souvenir of the occasion.

SINCE the advent of aviation visibility over the land has advanced from occupying a secondary position to one of major importance amongst subjects of meteorological investigation. During the past few years the matter has consequently been engaging the close attention of meteorologists, and much progress has been made in the taking of accurate observations. In order to allow a free exchange of opinions on the subject, the meeting of the Royal Meteorological Society to be held at 5 p.m. on December 14 will be devoted to a discussion on "Visibility." The discussion will be opened by Mr. F. J. W. Whipple, who will give a general introduction, while other speakers will approach the matter more particularly from the points of view of the airman, the seaman, and the physicist. The subject of London fogs will also be introduced. Those desirous of obtaining tickets for the meeting should apply to the Assistant Secretary of the Royal Meteorological Society at 49 Cromwell Road, South Kensington.

AT the monthly meeting of the Zoological Society of London held on November 23 twenty new fellows were elected to the society, eighty-seven candidates proposed for election as fellows, two as foreign members, and eight as corresponding members. The report of the council showed that 509 additions had been made to the society's menagerie during the quarter, including 165 by presentation, 182 by purchase, 98 by deposit, 29 in exchange, and 35 born in the gardens. Special mention is made of a collection of mammals, birds, and reptiles from New Guinea and Aru obtained by Mr. Frost, which included four species of birds-of-paradise and several rare doves and parrots new to the collections. The number of visitors during the quarter showed a decrease of 108,735 and the receipts a decrease of 844*l*. as compared with the corresponding period of last year. Two hundred and ninety-eight new fellows have been elected to the society since January 1. The society's silver medal was presented to H.E. Capt. C. H. Armitage, Chief Commissioner of the Northern Territories,

Gold Coast, for his many valuable gifts to the collections from 1904.

ON the arrival of the *Quest* at Rio de Janeiro Sir E. Shackleton announced a change in the plans of his Antarctic expedition. According to the *Times*, Rio de Janeiro instead of Cape Town will be the base of the expedition, and the *Quest* was to sail about December 5 direct to South Georgia, arriving there about Christmas Day and leaving at the New Year for Enderby Land *via* Bouvet Island. An attempt will be made to prove the existence or non-existence of Thompson Island, an island reported to lie in the vicinity of Bouvet Island, but probably identical with the latter. Bouvet Island has been visited only once, namely, by the *Valdivia* in 1898, since its discovery in 1739. No landing has been made, and the island is reported ice-covered and inaccessible. Sir E. Shackleton hopes to enter the ice about January 22, and after visiting Enderby Land, if the ice permits, to arrive again at South Georgia by the end of March. There the *Quest* will coal and sail for Tristan da Cunha and Cape Town. The change in plans was attributed to the delay due to contrary winds and the weakness of the auxiliary engines. New topmasts were being fitted in order to increase the spread of canvas and allow the vessel to be driven through the pack-ice under sail. On the voyage to Rio de Janeiro a call was made at St. Paul's Rocks, which no ship appears to have visited since the *Scotia* in 1902. It is not reported if landing was found to be possible.

THE benefits conferred upon the native races of India by the presence in their midst of an energetic body of irrigation engineers were admirably set forth in two articles, entitled "Canals of the Punjab," by Lieut.-Col. Aubrey O'Brien, which appeared in the *Daily Telegraph* for November 25 and 30. The articles dealt with the great irrigation schemes already carried out and those for which plans have been prepared. By the harnessing of the waters of the Jumna, Sutlej, Ravi, Chenab, and Jhelum the area of irrigated land within the Punjab has been increased since the Mutiny from half a million to more than ten million acres. Worked entirely for the benefit of the people of the Punjab, the canals already return to the revenues of the province a profit of 14½ per cent. on the capital spent on them, and this with the lightest of dues. The present value of crops on 10,000,000 acres is considered to be not less than 50,000,000*l*. Great as these achievements are, they bid fair to be surpassed in importance and interest by the schemes due to Mr. W. H. Ives, the Chief Engineer of the Punjab, one of which, the Sutlej Valley Project, aims at irrigating very large areas in British territory, and also in the native States of Bahawalpur and Bikanir. It is estimated that this scheme, which will cost some 14,000,000*l*., will irrigate 9,000,000 acres. On the completion of this it is proposed to carry out another large scheme where the Sutlej emerges from the hills. The river here runs for forty miles in a great loop, piercing a range 3500 ft. high, and then turning back almost parallel to its previous course. At the gorge of Bhakra a dam 395 ft. high—50 ft. higher than any dam at present in existence—will be built, impounding a volume of water about three times greater than that held up by the Assouan Dam on the Nile, and it is anticipated that by utilising the water for driving turbines, power can be obtained up to 300,000 horse-power.

THE Copper Eskimo of Coronation Gulf were studied by the recent Canadian Arctic Expedition. Mr. D. Jenness, the anthropologist of the expedition, gives an account of these people in the *Geographical Review* for October. Until 1838 these Eskimo, who inhabit Coronation Gulf, Union and Dolphin Straits, and Kent Peninsula, were practically unknown, and after that date they were seldom encountered until the Canadian Arctic Expedition visited them in 1914. Mr. Jenness says that he found them still practically in the Stone age, but changes have occurred in the last few years. Contact with European fur traders has led to the introduction of metal goods, rifles, changes in clothing and mode of life. The habits of the people are changing, and their greater success in hunting bids fair to exterminate the caribou. Mr. Jenness views with some concern the contact of civilisation with these Eskimo, and, by reason of scarcity of caribou and introduced white man's diseases, fears that before long they may dwindle to a degenerate remnant on the way to extinction.

A DEPLORABLE instance of misdirected energy is recorded in the November issue of *British Birds*, where Mr. W. Rowan, in the course of a most admirable account of the breeding haunts and habits of the merlin, tells us that on the two moors which formed the area of his investigations "it is but rarely that a hawk attempting to breed survives . . . to tell the tale." The moors in question—the Barden and Embsay moors—form a single stretch nearly twenty square miles in area. During nineteen successive years no less than nineteen pairs of merlin were killed on *one* nesting-site only—"one pair each year without a miss, and not a single egg was hatched." Moreover, it would appear that every one of these wretched birds was trapped. The annual average of breeding merlins on this moor appears to be three or four pairs; not a single pair succeeds, save perhaps by the merest accident, in escaping destruction. This lamentable state of affairs, we fear, can be remedied only by the help of the owner of the moor, and it is to be hoped that steps will immediately be taken to extend protection against this senseless and unwarranted persecution, for there is no justification for the implied game-destroying habits of these birds.

To the *Lancashire and Cheshire Naturalist* for July–August Dr. J. Cosmo Melville contributes an interesting series of notes on the Sidebotham collection of Lepidoptera in the Manchester Museum. Very nearly all the British species are represented in the collection, and it contains fine series of many varieties, and also material of historical interest. The now extinct butterfly *Chrysophanus dispar* is represented by twenty-seven perfect specimens, and the very rare hawk moth, *Choerocampa celerio*, by five examples

with full data. There are two Staffordshire examples of *Leucodonta bicoloria*, and one of the two authenticated British examples of *Byrophila algae* is in this collection. In a brief article on the growth of the Manchester Museum Mr. T. A. Coward points out that that institution is now exceptionally rich in valuable collections; in fact, few provincial museums can vie with it in this respect. The famous Dresser collection of birds and eggs and the valuable ornithological library attached thereto are almost indispensable to serious students. In the botanical department of the museum are located the huge herbaria of Dr. Cosmo Melville and Mr. Charles Bailey, along with the Barker and other cryptogamic collections.

THE annual report of the Meteorological Office for the year ended March 31, 1921, has been submitted to the Air Council for the first time since the control has been taken over from the Lords Commissioners of His Majesty's Treasury. The period dealt with was a time of transition and reorganisation, an important change being the retirement of Sir Napier Shaw from the directorship after twenty years' service and the appointment of Dr. G. C. Simpson to the vacant position. Among the many changes made in the carrying on and extension of the work at its different centres of activity a considerable increase has been made in the staff employed. At the commencement of the year the clerical, technical, and unclassified posts numbered 182, and at the end of the year 213, leaving 65 vacancies to be filled to bring the staff to its required strength. There is a restriction that candidates must be drawn from ex-Service men. The Marine Division of the Office deals with the issue of meteorological and ocean-current charts, together with other weather information for the sailor. The Forecast Service, in addition to publishing the *Daily Weather Report*, is taking advantage of every opportunity to improve the value of the daily weather forecasts and harvest forecasts, a spell notification being issued for the latter when conditions are favourable for two or three days of fair weather. Climatological observations are issued in the *Weekly Weather Report* and in the *Monthly Weather Report*. The meteorology of the whole globe is also now regularly discussed. The British Rainfall Organization is being controlled by the Meteorological Office, and the publication of rainfall statistics for the British Isles occupies much time. Observations on the upper air also involve a large amount of work.

THE Faraday Society has issued as a separate pamphlet of 83 pages an account of the discussion on electro-deposition and electro-plating which took place at the joint meeting of the society and the Sheffield Section of the Institute of Metals in November, 1920. Of the recent improvements referred to in the papers read and the discussion which ensued, one of the most important is the electro-deposition of the water-jackets of aeroplane engines and the possibility opened out by this success of building up elaborate parts of machinery by the same process. The advantages of cobalt-plating have been recognised for twenty years, but it is pointed out that there is still difficulty in securing the perfect adhesion of thick deposits. The influence of colloids in the depositing tank on the properties of the deposit is still imperfectly understood, although it seems undoubted that their presence leads to a decrease in the size of grain deposited. The chairman and one of the speakers expressed regret that some of the authors of papers had not made themselves acquainted with the work of previous investigators before commencing their own experiments.

IN the *Chemical News* of October 28 Prof. B. Brauner, of Prague, discusses the official report of the International Commission on Chemical Elements (NATURE, August 18, p. 787). He cannot accept the principle that "exact atomic weights are now becoming factors of an analytical calculation rather than features of a chemical hypothesis." Prof. Brauner has also the support of another authority on atomic weight determinations, Sir Edward Thorpe, who in his presidential address to the British Association at Edinburgh, considered it of importance to "determine with the highest attainable accuracy the departures from the whole number rule." Prof Brauner raises the following questions: "Why do we find with our chemical processes and the balance that the *atomic weights* of the pure elements, C, N, P, S, are *larger* than their *atomic masses* [as found by the positive-ray method]; why those of As, I, and Cs are smaller, and why those of He, O, F, Na, are exactly equal to their atomic masses, or in other words, why is the hypothesis of Prout in its modern form valid for atomic masses, but only in four out of twelve cases for the corresponding atomic weights? Another interesting question arises: Why are Aston's isotopes, as far as we know, always mixed up in the same proportion?" In the *Philosophical Magazine* for October Sir E. Rutherford gives reasons for the value, 14·01 (adopted by chemists) rather than 14·00, found by the positive-ray method, and suggests that a refinement of the latter method might distinguish between the two values.

WE have received from Messrs. Kodak a forty-eight-page booklet, entitled "X-Rays," which they are distributing to the members of the medical profession. It explains in a clear way the funamental laws of practical importance that underlie the production and use of X-rays, giving, for example, the relationship between the length of the spark gap and the required exposure, and the quality of the negative. The development and other treatment of the exposed plate or film is dealt with at length. The special aim of the booklet is the standardisation of procedure, so that the uniformity of method shall simplify diagnosis.

SINCE the introduction of the steam turbine the question of the production of high-speed gear-wheels has occupied the attention of many engineers. Generally, the type of gear-wheels employed has been double-helical. In a paper read by Eng.-Lt.-Comdr. L. J. le Mesurier on November 22 before the North-East Coast Institution of Engineers and Shipbuilders, the Maag gearing is described and

the process of manufacturing it is explained. This gearing is of the straight-toothed type, and has been developed by the Maag Gear Co., of Zurich. Means have been found by which straight-tooth spur gears can be employed successfully under conditions demanding the highest possible peripheral speeds and loads per unit width of tooth. The methods of production ensure the requisite degree of accuracy, and at the same time provide a tooth form which is considered to give the most favourable conditions of sliding contact during engagement. A novel grinding process has also been devised whereby it is possible to generate a correct profile on a case-hardened tooth surface by means which are independent of the wear which must take place on the grinding disc. The compensating arrangements in the grinding machine are extremely interesting, and keep the grinding planes in their correct position to within ±1/1000 mm. The gear has been applied to several ships and to a large number of electrical plants and electric-locomotive drives.

"A WINTER GUEST," the seasonable and striking Christmas card published by the Royal Society for the Protection of Birds (23 Queen Anne's Gate, S.W.), represents the redwing, sometimes called the "Norwegian Nightingale," though known in England only as a winter visitor. The picture is reproduced in colour from a painting by Mr. H. Gronvold, and gives very happily the character and the appealing expression of the little traveller. It can be had, with calendar, for 5*d.* by post.

ERRATUM.—The Poets' Corner of Westminster Abbey is in the south transept, and not the north, as stated in the article on "Science in Westminster Abbey" in last week's NATURE, p. 437.

Our Astronomical Column.

THE EFFECTIVE WAVE-LENGTH OF THE LIGHT OF GALACTIC STARS.—Prof. O. Bergstrand contributes a paper on this subject to the centenary number of *Astron. Nach.* The research is based on a series of plates of the star-cloud in Cygnus obtained with a 15-cm. triple objective prism. The spectral types of the brighter stars were taken from the Henry Draper catalogue, and the following table shows the correlation between type and effective wave-length λ.

Type	λ	Type	λ	Type	λ
O	411μμ	F	421	K	429
B	416	G	423	M	439
A	419	G5	425		

Only two M stars were available, both probably giants. From the evidence of the G5 and K stars, the author concludes that dwarfs have a smaller value of λ than giants of the same type.

An analysis is then given of the values of λ for the fainter stars down to magnitude 13·4. It is pointed out that the percentage of white stars is more than 60 for stars brighter than 11·4 m., and then drops suddenly to less than 50. He explains this by assuming that the white stars have the highest absolute brightness, and so are more distant than yellow or red stars of the same apparent magnitude. Hence we reach the limits of our local star system sooner in the white stars than in the yellow ones, causing a drop in the percentage for the fainter stars. Taking 0·0 as the absolute magnitude of an average giant white star, the radius of our local system is found to be 2500 parsecs.

THE DYNAMICAL EQUILIBRIUM OF THE STELLAR SYSTEM.—Prof. A. S. Eddington contributes an important paper to the centenary number of *Astron. Nach.*, in which he makes a further advance in the solution of this problem; his first approximation, in which he took the shape of the system as spherical, was published in Monthly Notices, R.A.S., vol. 75. He passes on in the present paper to consider the much more difficult problem of an oblate system, and succeeds in finding one exact solution as follows: A rotating system that has settled down to a steady state may be presumed to be oblate. If we divide it into two identically equal systems, and reverse the direction of rotation of one of them, we shall have a non-spherical system in equilibrium, with no rotation as a whole, but with preferential motion in a transverse direction. The solution is worked out in detail for a homogeneous spheroid, which is shown to be strictly analogous to Maclaurin's hydrodynamical spheroid. It is inferred that non-homogeneous solutions exist. In conclusion, he points out that it is quite likely that the stellar system has not yet attained dynamical equilibrium, and may be collapsing somewhat rapidly towards a steadier condition. He has hopes that the advance of knowledge of stellar masses and velocities may enable the matter to be decided by using the principle that in dynamical equilibrium the total kinetic energy is half the exhaustion of potential energy.

OBSERVATIONS WITH THE COOKSON FLOATING TELESCOPE.—This instrument, which floats in a circular tank containing mercury, was designed by the late Mr. Bryan Cookson, and given after his death to the Syndics of the Cambridge University Observatory. It has been on loan at the Royal Observatory, Greenwich, since 1911, and a memoir just published discusses the observations of the first seven years. The primary object was the redetermination of the aberration constant, while the variation of latitude is a useful by-product. Pairs of stars are selected at about the same distance from the zenith and on opposite sides, and with right ascension difference of a few minutes of time; their magnitudes vary from 5 to 6·5. The trails of brighter or fainter stars are too broad or too faint for accurate measurement. Three solutions are given for the aberration constant and for the corresponding value of the solar parallax as follows:—

Ab. const.	Parallax	
″		
20·442	8·815	General solution.
20·455	8·810	Discordant plates rejected.
20·460	8·808	Correction for wind direction applied.

The probable errors of aberration and parallax are 0·013″ and 0·006″ respectively. The third solution resulted from an examination of the "night errors," which led to the conclusion that they depend largely on the direction of the wind. This, combined with the dissymmetry of the ground-level to the north and south of the instrument, is presumed to produce inclination of the atmospheric strata and anomalous refraction. It will be seen that the values for the parallax do not differ too widely from Mr. Hinks's value 8·806″. The period of observation is, however, not considered quite long enough to eliminate accidental error, and the observations are being continued for another seven years.

Progress in Palæontology.

H. YABE and S. Endô (Sci. Rep. Tôhoku Uni., Sendai, Geology, vol. 5, p. 93, 1921) have re-examined the specimen believed to be a Sigillarian stem, found in Suruga Province by K. Fujii in 1915. While they suspend judgment on this specimen, they are now able to record the discovery of stems of Calamites by S. Makabe in the province of Iwami. These are the first Palæozoic land-plants recorded from insular Japan. The Carboniferous beds with which they are associated are marine, and it seems unlikely that any considerable flora will be unearthed comparable to that known from the adjacent continent.

Zoning by Foraminifera received a new impetus from the division of the well-known genus Orbitoides into a restricted group and two other genera. When cut horizontally, the equatorial layer in these discoidal forms shows chambers of lozenge shape in Orbitoides, which is Cretaceous, of rectangular shape in Orthophragmina (Eocene), and of hexagonal shape in Lepidocyclina (Upper Eocene and Oligocene). C. W. Cooke and J. A. Cushman ("Orbitoid Foraminifera from Georgia and Florida," U.S. Geol. Surv., Prof. Paper 108-G) in 1917 described forms of Orthophragmina, usually stellate, from the Ocala Limestone of the south-eastern States, and thus assigned to this horizon an Eocene age. In Prof. Paper 125-D, 1920, J. A. Cushman investigates and illustrates by bold photographs "The American Species of Orthophragmina and Lepidocyclina." Many of these forms were described by the author in 1919 in Pub. 291 of the Carnegie Institution; but thirteen others are new, and the whole group will be of interest for comparison with those of India and other countries. From Japan, for instance, we receive H. Yabe's "Notes on two Foraminiferal Limestones from Borneo" (Sci. Rep. Tôhoku Univ., Geology, vol. 5, p. 100), with illustrations of flexed forms of Orthophragmina side by side with Assilina and Nummulites. Yabe also describes (p. 97) four species, representing three genera, of arenaceous foraminifera that came to light on cleaning Japanese nummulites to which they were adherent. This opens a suggestive line of research.

T. W. Vaughan (U.S. Geol. Surv., Prof. Paper 98-T) uses the reef-coral fauna of Carrizo Creek, California, to show that in Pliocene times a renewed connection took place between the Atlantic and the Gulf of California across Central America. Owing to the formation of a land area from north to south, Pacific elements disappeared from the Atlantic fauna after the Upper Oligocene epoch. At Carrizo Creek, however, Atlantic forms occur in Pliocene strata, similar to those of Florida and the West Indies, and there is, curiously enough, no admixture of Pacific forms. The belt of Cainozoic limestone in Porto Rico, with its curious "pepino" structure, has been mentioned recently in NATURE (vol. 105, p. 147). The New York Academy of Sciences now continues its scientific survey by issuing Bela Hubbard's report on "Tertiary Mollusca from the Lares District"; these are mostly of Middle and Upper Oligocene age. Among other works on mollusca we may note the additions to our knowledge of fossil Unionidæ in the Indian region made by E. Vredenburg and B. Prashad (Rec. Geol. Surv. India, vol. 51, pp. 368 and 371, 1921), since members of this family have hitherto been known only from the late Cretaceous intertrappean beds in the Peninsula and from the Lower Miocene of Baluchistan. Prashad's *Lamellidens Vredenburgi* is from the intertrappean beds of Narbada; it is the oldest known representative of this genus, which is one of the dominant members of the Unionidæ in the modern Indian fauna, and it is thus probably very near the point at which Lamellidens branched from Unio. In another recent part of the Records (vol. 51, pp. 66–152) E. Vredenburg reviews the whole family of the Cypræidæ, the earliest known members of which are the strongly differentiated genera Gisortia and Eocypræa in the Albian stage. He emphasises d'Orbigny's separation of Ovula, a delicate shell that probably existed before Eocene times, and would (p. 82) ally it to the Strombidæ rather than the Cypræidæ.

The Yorkshire Geological Society (Proc., 1919–20, p. 359) publishes the last work of the late Lt.-Col. Wheetton Hind, who was equally devoted to Carboniferous fossils and to his artillery in the field. Goniatites are here described from a zone lower than any previously known in the British Carboniferous series, the Upper C Beds of Vaughan, and this record from Kniveton, Derbyshire, is worth making, though the species are not new. S. S. Buckman's fine work on "Type Ammonites" has been recently referred to in NATURE (vol. 106, p 103), and has now reached its twenty-eighth part. New names seem abundant and inevitable, but there is something magniloquent in the passage of *Ammonites giganteus* into *Titanites titan*. J. W. Tutcher's beautiful illustrations will console and guide curators who have the courage to start afresh on their collections.

P. E. Raymond's "Contribution to the Description of the Fauna of the Trenton Group" (Canada Geol. Surv., Museum Bull. 31, 1921) contains a number of observations on cystidea. The photograph of four discoidal specimens of Isorophus in their natural position on the sea-floor is a pleasing picture of Ordovician times. The species figured, which is common at Ottawa, has hitherto been regarded as *Agelacrinites Billingsi*. Prof. Raymond has undertaken a far more ambitious piece of work in his monograph on "The Appendages, Anatomy, and Relationships of Trilobites" (Mem. Connecticut Acad. Arts and Sciences, vol. 7, 1920, Newhaven, Conn., 6 dollars). This is dedicated to the memory of C. E. Beecher, whose numerous photographs of specimens showing appendages are here for the first time reproduced. Dr. Elvira Wood has rendered great assistance in her reconstructions of trilobites in their habit as they lived. We wish that Miss Woodward's sombre drawings of marine life in Palæozoic times could have found a place in the bibliography; Prof. Raymond, however, attributes to most trilobites a power of swimming that lifts them well above the level of H. M. Bernard's "browsing annelids" (Quart. Journ. Geol. Soc., vol. 51, p. 358). When we regard Burmeister's "View of an *Asaphus cornigerus* from below" (Ray Soc. ed., pl. 6, Fig. 8), with its attempt at the restoration of parts that were believed to be irrecoverable, we can imagine how this pioneer would have hailed the delicate drawings of Ceraurus (pl. 11), Triarthrus, and Neolenus in the present memoir. Burmeister emphasised the relationship of the trilobites to the phyllopod Branchipus; Bernard found their nearest ally in Apus; Raymond (p. 127) now observes that "the thoracic limbs of Apus must be looked upon as highly specialised instead of primitive," since the ancestral Branchipoda of Middle Cambrian times had simple biramous appendages. He believes (p. 146) that the higher crustacea are all derived from the trilobita,

and that the ancestor of the latter was a pelagic arthropod with few segments, the crawling habit being a modification. The carapace may have been developed in consequence of this habit, and may at first have been unsegmented. The numerous appendages arose at this stage, but their presence broke up the dorsal test into corresponding segments as swimming and crawling activity developed. The elongate worm-like character of some trilobites with many segments, such as Robergia of the Middle Ordovician, is thus held to be a secondary character (pp. 138 and 151). Walcott's Marrella (p. 115) from the Middle Cambrian is here handsomely restored, and so far no biramous appendages are known in connection with its head-shield. It is regarded (p. 143) as an already specialised link between the trilobites and the higher crustacea. Raymond's thoughtful and stimulating work revives many memorable discussions, and it reverses accepted opinions for reasons that are simply stated. The details of Beecher's observations receive their fullest exposition and illustration from a pupil who has used them aptly as a basis for independent thought.

In the palæontology of early vertebrates even a footprint may count for much. Our minds are still obsessed by the mysterious impressions in Devonian strata to which Marsh assigned the name Thinopus. R. S. Lull's traces of *Dromopus* (?) *Woodworthi*, n. sp. (*Amer. Journ. Sci.*, vol. 200, p. 234, 1920), from an Upper Carboniferous shale in Massachusetts, are regarded by the author as possibly reptilian. It is pointed out that Williston's *Isodectes Copei* would have made an impression much like that already known as *Dromopus agilis*, Marsh; both these are Carboniferous, and Isodectes is already held to be a reptile. Chelonians are prominent in two recent papers. Eduardo H. Pacheco (*Iberica*, vol. 15, p. 328, 1921) gives photographs of the wonderful assemblage of gigantic turtles in an Upper Miocene flood-deposit in the Otero de Palencia, a hill rising from the tableland of Old Castile. Similar forms are known from the Miocene continental deposits of the neighbourhood, but the examples at Palencia, 1½ metres in diameter, seem to have been brought together by the sudden overflow of a river that entombed them in its sand. They resemble the living, but distinctly smaller, tortoises of the Galápagos Islands; the islands, by the by, received their name from these quaint inhabitants. Nine specimens have been unearthed, and those in a fair state of preservation are destined for the museum in Madrid. C. W. Gilmore (U.S. Geol. Surv., Prof. Paper 98-Q) describes well-preserved carapaces of turtles in the Ojo Alamo (late Cretaceous) sandstone of New Mexico. Associated with them are handsome skulls of the dinosaurian Kritosaurus, a genus described by B. Brown in 1910. The author in a second paper (Prof. Paper 103) introduces a newly found dinosaur, Brachyceratops, from beds of similar age in north-western Montana. The modelled restoration (pl. 1) is founded on a skull and on the scattered remains of five individuals (compare pl. 4). It is represented with two stumpy horns, supraorbital and nasal, and a conspicuous bony frill extending backwards, but by no means so deterrent as that of Triceratops. The specimens are small, and may be immature. The length of the skull is 565 mm. A few other reptilian remains are noticed in the paper.

The Marsh collection at Yale continues to supply material for a number of researches on Cainozoic vertebrata. R. S. Lull describes Oligocene camels (*Amer. Journ. Sci.*, vol. 201, p. 392, 1921); E. L. Troxell (*ibid.*, vol. 200, pp. 243, 361, and 431, 1920) examines the giant pigs styled entelodonts, and introduces the new genera Megachœrus and Chærodon. The skull of the former has a length of 760 mm. and singularly large plate-like dependent malar processes (p. 433). The canines of Chærodon are remarkably recurved (p. 442). Both these genera are Oligocene. The same author (*ibid.*, vol. 202, p. 41, 1921) deals with the origins of the rhinoceros. He points out that in fossil forms the females are hornless, while the males have horns, and that the term Aceratherium, used for all hornless rhinoceroses, ceases to be of value. Other characters than those of the nasal bones indicate, however, that there is a group to which the name may be restricted in the Old World. Troxell lays much stress on Cænopus, of the American Middle and Upper Oligocene, as the ancestor of all later forms, including the modern genera of rhinoceroses. In connection with this point, the observations of H. Matsumoto are of interest (Sci. Rep. Tôhoku Univ., Sendai, Geology, vol. 5, p. 75, 1921), since the author suggests the migration of the Miocene rhinoceros Teleoceras (pp. 81 and 88) from Palæarctic Asia to North America, together with other mammalian forms. He describes a new species from Japan, which he regards as more archetypal than the American Teleoceras. Returning to the Marsh collection, M. R. Thorpe proposes some new terms to facilitate the use of skull-measurements in his review of the Oligocene felidæ (*Amer. Journ. Sci.*, vol. 200, p. 207, 1920).

G. A. J. C.

The Tea Industry.

"THE Production of Tea in the Empire and its Relation to the Tea Trade of the World" forms the subject of a comprehensive paper contributed by Mr. A. S. Judge to the Bulletin of the Imperial Institute (vol. 18, No. 4). The paper gives an interesting survey of the spread of tea-drinking in different countries, with particulars of the condition of the industry in all tea-producing areas.

Fifty years ago China and Japan produced practically all the tea consumed in the world; twenty years later, in 1890, India and Ceylon were seriously challenging China's monopoly, until at the present time they produce more than two-thirds of all the tea which enters the world's commerce, while their most serious competitor is Java, in which country tea can be produced more cheaply than in either India or Ceylon. At the beginning of 1919 prices in London for all grades of tea were good and stocks in the United Kingdom were not excessive, but apparently trade had been disorganised by the war and by Government control, and since none of the danger-signals pointing to over-production were raised, the plantations in the British and Dutch East Indies produced tea to their full capacity. The Russian market, which had been taking 100,000,000 lb. of plantation tea yearly, was lost, and large stocks began to accumulate, until in the middle of 1920 the actual situation was realised and there followed a break in prices for all the lower grades, which have since been selling below the economic value. There is no question regarding the soundness and ultimate prosperity of the Indian and Ceylon tea industries, but the immediate outlook for many estates is very critical, particularly those estates which produce mainly medium-grade teas.

It is to the common interests of both the producer and the consumer that the tea industry should be

placed on a sound basis. The most serious obstacle to the return of healthy trade conditions is the great accumulation of stocks of common teas. Since the Russian demand has ceased there appears to be little hope, at least in the immediate future, of reducing the volume of these stocks, but unless this is effected or the sales of tea are regulated there can be no recovery in prices for a long time.

In connection with this may be considered an article by Mr. J. W. McKay in the April issue of *Tropical Life*. The author considers that although at this period of depression in the tea industry the prospects are certainly dull, yet now is the time to make plans for the improvement of old tea estates in order to be ready for the better times ahead. With regard to many long-established estates it may be advisable to abandon certain areas as being too poor to be profitable, but the greater proportion will probably pay for better methods of cultivation. Most of the older tea estates show signs of reduced fertility, due partly to the rapid decay of organic matter which takes place in all tropical soils, but more particularly to the unrestricted "wash" which has been allowed to go on for years. Such action means that the fine soil particles are irrevocably lost, and when the surface-soil is once gone it cannot be easily replaced. When plenty of fresh land was available this deteriorated land was simply abandoned, and such will probably be the fate of considerable areas of old tea land. There is much to be said for this treatment, since it means that labour can be concentrated on the better areas which remain. Several methods for improvement are discussed: the construction of terraces and the planting of such shrubs as *Tephrosia candida* to prevent loss of surface-soil, trenching, limited collar pruning accompanied by manuring, the provision of adequate shade (since tea was originally a jungle plant), and, finally, an intelligent use of artificial fertilisers.

University and Educational Intelligence.

MANCHESTER.—On Saturday, November 26, a memorial tablet to the late H. G. J. Moseley was unveiled by Mrs. Sollas, the mother of this distinguished young man of science, in the presence of a considerable number of friends and colleagues. Prof. W. L. Bragg said that the request for funds for the purpose of commemorating Moseley's life and work in Manchester had met with a most generous response, both in this country and abroad, and in addition to setting up the tablet it had been found possible to institute a Moseley memorial prize in physics. Sir Ernest Rutherford spoke at some length of the brilliant achievements of Moseley in his all too short research career, and lamented the loss which science suffered when Moseley was killed at Suvla Bay. Prof. Rutherford recalled the affection which he and other co-workers cherished for Moseley. In conclusion he offered the memorial tablet to the University on behalf of the subscribers, and it was accepted by the Vice-Chancellor, Sir Henry A. Miers. The tablet is a circular one of bronze, and is fixed to the wall of the staircase outside one of the physical laboratories, and bears the words: "In Memory of Henry Gwyn Jeffreys Moseley, M.A. (Oxon.), Lecturer in Physics and John Harling Research Fellow in the University of Manchester, Lieutenant Royal Engineers, killed in action on Gallipoli, August 10, 1915, aged 28 years. Discoverer of the Law defining the Order and Number of the Elements."

AN address on "The Natural and Artificial Disintegration of Elements" is to be delivered to the Royal College of Science Chemical Society by Sir Ernest Rutherford to-day, December 8, at 4.30 p.m. Among other meetings of this society arranged for the current session are lectures by Prof. Norman Collie on "The Rare Gases," and by Sir William Bragg on "X-Ray Work," which will be delivered on January 26 and February 23 respectively.

THE annual meetings of the Geographical Association will be held at Birkbeck College on January 5–6. On the opening day the presidential address will be delivered by Lord Robert Cecil, and the following papers will be read: "London and Westminster Contrasted: A Study of the Geographical Factors which have Influenced their Situation and Development," by Mrs. Ormsby; "Problems of the Pacific," by Sir Halford Mackinder, and "The Anthropological Institute and the Services it can render to Geographical Students," by Mr. E. N. Fallaize. Mr. R. L. Thompson will open a discussion on geography and history in schools The papers to be presented on the second day of the meeting are as follows: "The Co-operation of Historians and Geographers," by Dr. H. J. Fleure (at King's College); "Some Climate Problems of Modern Palestine," by Miss L. Winchester, and "The Hejaz," by Dr. D. G. Hogarth.

THE Lord Mayor of London has issued an appeal for English books for the University of Latvia, one of the new Baltic States, where it has been decided that English shall be the first foreign language to be taught both in the University and in the schools. English and English ideals will, therefore, henceforth take a very important place in the education of this new State. The teaching of English is, however, sadly hindered by the dearth of good books in our language, and the purchase of these at the present time by the Letts is impossible owing to the very adverse rate of exchange. This condition of things might easily be remedied, for there must be many hundreds of books—standard works in our language, disused school books, scientific, engineering, and other professional works—for which their owners no longer have any use. It is for books of these types, which might be used in teaching English, that the appeal is made. Gifts of books should be forwarded to Sir Alfred T. Davies, c/o the Consul-General for Latvia, 329 High Holborn, London, W.C.1.

ON November 29 H.E. the Swedish Minister and other members of the Anglo-Swedish Society listened to an interesting account by Mr. G. R. Carline of the visit which he made to Sweden this year, as a scholar of the society, to study the open-air museums of that country. Again in 1922 the society has decided to award two travelling scholarships of 50*l*. each to qualified British students of either sex residing in the British Isles to enable them to visit Sweden and there carry out a definite course of study. The following conditions are prescribed:—That the candidates should utilise their journey for definite investigation work; that they should present a report of their activities in Sweden; and that they should take up the scholarship within six months of nomination. Applications must reach the secretary of the society at 10 Staple Inn, London, W.C.1, not later than February 1, 1922, and should be accompanied by letters of recommendation from a university professor or from the head of a recognised institution. The

decisions of the committee will be announced not later than March 15, 1922.

A LIST of one hundred popular books in science compiled by a committee of the Washington Academy of Science is published in the Journal of the Academy of September 19 last. The list is strictly tentative, and the Academy invites criticisms and suggestions. The first test for the kind of book desired for the list was: Would the average reader who uses a public library, after beginning to read the book in question, read it through to the end and come back to the librarian for another on the same subject? The second test was that it should have been written by an author who understood his subject thoroughly, and that it should not be so old as to be obsolete in its facts and speculations. The committee points out that though librarians may be able to discover which books are interesting, they have no good way of finding out which of these interesting books are trustworthy and which are not merely unorthodox, but misleading or misinforming. It is here that a scientific body such as the Washington Academy is able to help. Ordinary text-books and books written in text-book style are excluded from the list. After each title the committee makes a short statement explaining why the book is recommended and how far more than a rudimentary knowledge of the subject is needed for its full appreciation. Although in a list compiled for American libraries one would expect to find that a majority of the books recommended were by American authors, we observe with satisfaction that no less than 43 out of the 100 books are by British authors. Among these we naturally find Charles Darwin, Francis Galton, and Robert Ball, but we must refrain from giving the complete list.

ATTENTION is being directed once more in the public Press to the scheme for raising University College, Reading, to the status of an independent university. So long ago as 1906 Lord Haldane predicted that within a few years the college would develop into a university, and in 1911 a committee, appointed in 1909 to consider the question, reported in favour of such a project, and at the same time, for its furtherance, an endowment fund of 200,000*l.* was presented to the college by the late Mr. G. W. Palmer, the late Lady Wantage, and Mr. Alfred Palmer, the present chairman of the council. Preparations for applying for a charter as an independent university, interrupted by the war, were finally completed in June, 1920. The arguments relied on by the supporters of the scheme were summarised in an article which appeared in these columns eighteen months ago. Briefly, they are as follows:—Large existing endowments (265,000*l.*); heavy and increasing enrolment of students (more than 1600 in 1920–21, including 549 full-time students); residential accommodation more ample than in any modern English university; adequate equipment for teaching and, in several departments, for research; a reputation which draws students not only from distant parts of the United Kingdom, but from the Continent and the British Dominions overseas. The Privy Council considered the application sympathetically, but decided against the immediate grant of a charter; they suggested the renewal of the application, however, when the number of full-time students should have further increased and the income should have been raised to about 80,000*l.* The council has resolved to apply itself with ardour to the task of fulfilling these conditions. An offer by Messrs. Huntley and Palmer of a donation of 10,000*l.* to the college for the purposes of agricultural research has just been announced, one of the conditions being that the college obtains a university charter.

Calendar of Scientific Pioneers.

December 8, 1864. George Boole died.—While professor of mathematics at Queen's College, Cork, Boole published his "Differential Equations" and his "Calculus of Finite Differences," in both of which he employed symbolic methods. His "Laws of Thought" (1854) is one of the first attempts at "the employment of symbolic language and notation in a wide generalisation of logical processes."

December 8, 1894. Pafnutiy Lvovich Chebichev died.—One of the most eminent of Russian mathematicians, Chebichev held the chair of mathematics in the University of St. Petersburg from 1859 to 1880, and wrote memoirs on the theory of numbers, the theory of probabilities, quadratic forms, and other subjects.

December 9, 1891. Sir Andrew Crombie Ramsay died.—The successor in 1871 of Murchison as director of the Geological Survey of Great Britain, Ramsay also held the chair of geology at the Royal School of Mines. Accounted the best field geologist in the country, he also contributed to physical and dynamical geology.

December 9, 1908. Oliver Walcott Gibbs died.—Graduating in medicine at New York, Gibbs studied under some of the great chemists of Europe, and afterwards held professorships at New York and Harvard. He did original work in inorganic chemistry and was among the first in the United States to introduce research as a means of instruction.

December 10, 1889. Lorenzo Respighi died.—Like his countrymen Secchi and Tacchini, Respighi was devoted to spectroscopy, and added much to the knowledge of solar physics. From 1865 he held a chair of astronomy at Rome.

December 12, 1777. Albrecht von Haller died.—Scholar, poet, botanist, anatomist, and physiologist, Haller held a chair at Göttingen, where he organised a botanical garden and an anatomical theatre, and helped to found the Academy of Sciences.

December 13, 1565. Konrad von Gesner died.—One of the "Encyclopædic" naturalists, Gesner was called by Cuvier "the German Pliny." He was professor of Greek at Lausanne and professor of natural history at Zurich. His "Historia Animalium" (1551–58), designed to contain all then known of every animal, has been referred to as the starting-point of modern zoology.

December 13, 1891. Jean Servais Stas died.—After working for a time in conjunction with Dumas at Paris, Stas settled in Brussels and devoted himself mainly to the precise determination of atomic weights, for which in 1885 he was awarded the Davy medal of the Royal Society.

December 14, 1557. Niccolo Tartaglia died.—The contemporary and rival of Cardan, Tartaglia was a self-taught mathematical genius who commenced lecturing at Verona, and in 1535 was appointed to a chair at Venice. His "Nuova Scienza" appeared two years later. Cardan published Tartaglia's solution of a cubic equation without authority.

December 14, 1873. Jean Louis Rudolphe Agassiz died.—Known first for his epoch-making work on fossil plants and his glacial studies, Agassiz in 1846 left Switzerland for the United States, where he afterwards occupied a leading position in the world of science. He held a chair at Harvard, founded the Museum of Comparative Zoology, and contributed much to the natural history of both South and North America. He was among those who did not accept the doctrine of evolution. E. C. S.

Societies and Academies.

LONDON.

Royal Society, November 24.—Prof. C. S. Sherrington, president, in the chair.—K. **Sassa**: (1) Observations on reflex responses to the rhythmical stimulation in the frog. In the study of the relation between the frequency and intensity of stimulation and the resulting reflex reactions, there is an optimal intensity when the rate of stimulation is rapid. There is also an optimal rate for any given intensity. The reflex contraction evoked at this rate is often nearly as powerful as the direct one obtained by similar stimulation. (2) The effects of constant galvanic currents upon the mammalian nerve-muscle and reflex preparations. The main points of inquiry have been: (*a*) The relation between reflex excitation and inhibition of the decerebrate tonus of the vasto-crureus; (*b*) whether the "excitation formula" (Pflüger's law) holds good in mammalian afferent nerves; and (*c*) whether there is continuous excitation during the passage of the current through an afferent nerve.—E. **Ponder**: The hæmolytic action of sodium glycocholate. The hæmolytic power of sodium glycocholate is greatly increased by the addition of small amounts of histamine or histidine. Erythrocytes can be rendered immune to the hæmolysis produced by such mixtures by the previous addition of histamine to the suspension. The hæmolysis is probably due to changes of surface tension.—Dorothy J. **Lloyd** and C. **Mayes**: The titration curve of gelatine. Hydrochloric acid combines with gelatine in solutions the acid concentrations of which are less than 0·04 normal, according to the law of mass action. K_b for gelatine is $4{\cdot}8 \times 10^{-12}$ if 839 be taken as the reacting weight of gelatine. Combination probably occurs at the free $-NH_2$ groups present in some of the amino-acids of the gelatine. In dilute sodium hydroxide (less than 0·01 normal), gelatine combines with the base at a slower rate than that calculated from data used in acid experiments. The number of positions of attachment for bases is probably not the same as the number of positions for acids.—D. H. **de Souza** and J. A. **Hewitt**: Idio-ventricular periodicity. A perfusion experiment on the excised heart of the frog was described, in which periodic grouping occurred as an independent ventricular phenomenon.

Zoological Society, November 22.—Prof. E. W. MacBride, vice-president, in the chair.—A. S. **Le Souëf**: The early life-history of Ornithorhynchus.—A. **Smith Woodward**: A human skull and other remains from Broken Hill, North Rhodesia, upon which the species *Homo rhodesiensis* was founded. In comparing the Rhodesian skull with a Neanderthal skull from La Chapelle, the author stated that the former may prove to be the next grade after Neanderthal in the ascending series.—C. F. **Sonntag**: Contributions to the visceral anatomy and myology of the Marsupialia.—H. **Matsumoto**: Megalohyrax (Andrews) and Titanohyrax, g.n. A revision of the genera of Hyracoids from the Fayûm, Egypt.

Geological Society, November 23.—Mr. R. D. Oldham, president, in the chair.—K. W. **Earle**: The Lower Carboniferous rocks of West Cumberland. The zonal sequence of the Carboniferous rocks of Westmorland and Lancashire is traced into Cumberland. The lowest beds resting against the Lake District massif belong to the *Nematophyllum-minus* sub-zone. The only outlier of Carboniferous Limestone within the massif itself consists, at the base, of beds of that zone. The Lake District massif was probably an island in earliest Carboniferous times, and complete submergence did not take place until D_1 times. The irregular distribution and thickness, the constituent materials, and the high angle of dip of the Polygenetic Conglomerate beneath the gently dipping limestones, confirm earlier conclusions as to its Devonian age. The Millstone Grit is variable in thickness, composition, and stratigraphical horizon in various parts of the area, and there are valuable iron-ore deposits in the limestone series near Whitehaven.—W. G. St. John **Shannon**: A composite sill at Newton Abbot (Devon). The intrusive nature of the sill, which occurs at the summit of Knowle's Hill, is shown by the spotting of the overlying slates. Considerable differentiation has taken place, and the sequence is that of a plutonic phase from basic to more acid, in the order: picrite, dolerite, bostonite; mugearite occurs as a modification of the dolerite. The somewhat sharp junctions and the xenoliths of picrite in dolerite suggest that differentiation took place in the magmatic reservoir. Intrusions occurred before the cooling of the earlier rocks, since the newer show no selvage. Intrusion probably took place during the later stages of folding, but before final cessation of the movement.

DUBLIN.

Royal Dublin Society, November 22.—Dr. F. E. Hackett in the chair.—W. R. G. **Atkins**: (1) Some factors affecting the hydrogen-ion concentration of the soil and its relation to plant distribution. The reaction of the soil is considered in relation to the limiting hydrogen-ion concentrations of solutions of various carbonates, and to these as altered by other salts. The availability of phosphates and iron salts varies with the soil *p*H values. Heating increases the *p*H value of alkaline soils. There is a relation between the typical reactions of the soil and the rocks, limestone, sandstone, slate, plutonic, etc., giving rise to it. Plant distribution is limited in a very definite manner by the *p*H value of the soil, as shown by study of a hundred species. Natural fresh-water has been found to vary from *p*H6·4 to 8·3, or when insolated with algæ to *p*H9·7. (2) The hydrogen-ion concentration of plant-cells. An acidity as great as *p*H1·4 has been observed in sap; plant-cells are rarely alkaline. Microchemical tests show that the xylem is more acid than the pith and medullary rays. The transpiration stream in Colocasia is almost neutral, but the glandular secretions of *Drosera rotundifolia* are acid, *p*H5. The acidity of a tissue is usually near, but below, the optimum for the action of its characteristic enzyme. For such tests diethyl-red is a useful indicator. (3) Note on the occurrence of the finger-and-toe disease of turnips in relation to the hydrogen-ion concentration of the soil. Soil giving a badly infected crop was found to contain 0·17 per cent. of calcium oxide and to be as acid as *p*H6·6; the adjoining field, which gave a good undiseased crop, had 0·40 per cent. of calcium oxide, and was at, or slightly more than, *p*H6·7

EDINBURGH.

Royal Society, November 7.—Prof. Bower, president, in the chair.—C. V. **Raman**: The phenomenon of the radiant spectrum observed by Sir David Brewster. Brewster observed early last century that when a bright image of the sun was observed through a prism of small dispersion there was seen beyond the violet end of the spectrum a bright radiant source. This is explained in terms of the diffraction of the light through the diffracting medium of the eye.—Henry **Briggs**: Prehensility, a factor of gaseous adsorption. Experiments were described on the adsorption of different kinds of charcoal and silica at very low

pressures and at the temperature of liquid air, the practical aim being to determine the vacuum-producing power of such adsorbents, especially in regard to the efficiency of metallic Dewar vacuum vessels. The paper also discussed the advantage of evacuating by means of charcoal contained, not in a single vessel, but in a series of vessels, which are to be utilised in succession.—Henry **Briggs**: The Military Physical Test Station, Edinburgh. The purpose of the station was to test men drawn from the Army units in Scotland who proved to be refractory material in the hands of the drill sergeant, and to discriminate between the malingerer and the person who was actually of low physical capacity. The method of testing was determined after a long series of experiments. Instructive cases were cited and graphical records shown as to the physical performance of different men.—E. T. **Whittaker**: Tubes of electromagnetic force. A mathematical investigation on four-dimensional relativity lines, which by generalising the conception of tubes of force co-ordinated in an interesting way the electrostatic and the magnetic tubes created by Faraday and developed by Maxwell, Sir J. J. Thomson, and others.

PARIS.

Academy of Sciences, November 21.—M. Georges Lemoine in the chair.—MM. **Constantin** and **Dufour**: Researches on the biology of the Monotropa. At a spot in the forest of Fontainebleau *Monotropa Hypopithys* has been found growing abundantly, and this material has been examined for a fungus, since *Calluna vulgaris,* and other species of Ericaceæ have been shown to carry a fungus. A species was found, apparently new, to which the provisional name of *Monotropomyces nigrescens* has been given, and details are given of the media upon which this can be grown.—A. **Calmette,** L. **Nègre,** and A. **Boquet**: Tuberculous antibodies. It is concluded from the experiments described that the antibodies—"Sensibilisatrices antituberculeuses"—even when employed in large doses, have no bactericidal power, and are incapable of producing the disintegration, either *in vitro* or *in vivo,* of the tubercle bacillus. They do not neutralise tuberculin, and exert no favourable influence on the course of tubercular infection. Hence it is useless to place the slightest hope in the therapeutic effects of the antibodies contained in the so-called antituberculous sera.—M. Marcel Brillouin was elected a member of the section of general physics in succession to the late M. G. Lippmann.—T. **Varopoulos**: Some properties of increasing functions.—G. **Julia**: Integral or meromorphic functions.—M. **Riabouchinski**: The resistance of viscous fluids.—H. **Grouiller** and J. **Ellsworth**: New elements of light variation of the variable star VV Orionis. A study of the changes in brightness of variable stars in the cases due to eclipses has shown that there are many difficulties in the interpretation of the observations, due probably to imperfection of the data. The star VV Orionis of this type has been chosen for detailed examination, and 300 observations taken between November 3, 1916, and March 11, 1921, by J. Ellsworth are now discussed. The value for the period given by Hertzsprung is appreciably modified (+0·00842 day).—F. **Michaud**: The surface tension of electrified liquids. It is shown that theoretically, from the principle of energy, the surface tension should be independent of the state of electrification of the surface. This conclusion has been verified experimentally, a method being chosen which eliminates the effects of electrostatic repulsion.—A. **Sellerio**: The thermal analogue of the axial galvanomagnetic effect.—E. **Berger** and G. **Crut**: The equilibrium in the reduction of nickel chloride by hydrogen. The reaction indicated by the equation

$$NiCl_2+H_2 \rightleftharpoons Ni+2HCl$$

is reversible, and the equilibrium concentrations are the same, starting either from left or right. The constant K in the Nernst equation has been determined, K=5·93.—L. **Guillet**: The thermal treatment of certain complex aluminium alloys. In order to extend and explain the results obtained by the thermal treatment of duralmin, alloys of aluminium and copper, aluminium and silicon, aluminium, silicon, and copper, aluminium, silicon, and magnesium, and alloys containing all four constituents, have been studied, and the results of the micrographic examination are given. In all cases the simultaneous presence of silicon, magnesium, and copper is indispensable to obtain the interesting results given by tempering high resistance aluminium alloys.—E. **Grandmougin**: Octobromindigo.—C. **Dufraisse** and P. **Gérald**: The supposed true dibenzoylmethane of Wislicenus: some new experiments. In an earlier communication it has been shown that the Wislicenus compound is probably not $(C_6H_5{\cdot}CO)_2{=}CH_2$. From the results now given it is concluded that the supposed dibenzoylmethane of Wislicenus is $C_6H_5{\cdot}CO{\cdot}CH{=}C(OC_2H_5){\cdot}C_6H_5$, and the mechanism of its production is explained.—G. **Denizot**: The upper peneplain of the Paris basin and the primordial levellings of the periphery.—O. **Mengel**: The Canigou and the Maladetta, poles of the primitive axis of the Pyrenees.—S. **Stefanescu**: The practical and phytogenetic importance of the T_4 of the molars of mastodons and elephants.—F. **Kerforne** and Y. **Milon**: Observations on two recent shocks of the Armorican massif.—J. **Lacoste**: Contribution to weather prediction, especially storms, by observations with pilot balloons.—G. **Guilbert**: The formation of rain and the origin of cirrus clouds.—Ph. **Schereschewski** and Ph. **Wehrlé**: The movement of the nuclei of pressure variations.—Mlle. Y. B. **de Black** and P. **Marty**: The constitution of the Cantalian volcanic massif.—St. **Jonesco**: The transformation of the chromogens of some plants into a red pigment by oxidation.—H. **Ricome**: The problem of geotropism.—R. **Morquer** and J. **Dufrenoy**: Contribution to the study of the formation of a jelly from the lignified membrane of the Spanish chestnut.—E. **Chemin**: The corrosive action of plant roots on marble. The etching action of plant roots on polished marble has been variously attributed to the action of acetic, propionic, butyric, malic, and hydrochloric acids secreted by the root hairs. The author's experiments lead him to the conclusion that the roots of plants excrete no sensible amounts of any acid other than carbonic acid, and it is shown that this excretion is sufficient to account for the corrosion of the marble.—M. **Marage**: Protection against sound vibrations.—L. **Pellegrin**: The reproduction in an aquarium of a Brazilian fish, *Acara tetramerus.*—L. **Boutan**: The origin of the pearl sac and the mode of formation of pearls.—E. **Fauré-Fremiet**: Constitution of the egg of *Sabellaria alveolata.*—Mlle. H. **Goldsmith**: The phototropic reactions of some marine animals.—E. **Le Danois**: The biology of the white tunny-fish.—Ed. and Et. **Sergent,** L. **Parrot,** A. **Donatien,** and M. **Béguet**: The transmission of the Biskra boil by *Phlebotomus papatasi.*

MELBOURNE.

Royal Society of Victoria, July 14.—D. K. **Picken**: The Euclidean geometry of angle. The author introduces a fundamental geometrical figure, the complete angle, intermediate between straight line and (complete) triangle, with the notations (l_1, l_2), (AB, CD),

or simply AOB, equivalent to (OA, OB). The complete angle congruence, expressed as $(l_1, l_2) \equiv (l'_1, l'_2)$, or $AOB \equiv A'O'B'$, is shown to be the characteristic angle relation of elementary geometry; its use gives greater simplicity and generality to geometrical theory.

Books Received.

Seventh Scientific Report on the Investigations of the Imperial Cancer Research Fund. Pp. viii+91+22 plates. (London: Taylor and Francis.) 15*s*.

Report of the Canadian Arctic Expedition, 1913–1918. Vol. 5: Botany. Part A: Vascular Plants. By J. M. Macoun and T. Holm. Pp. 25+13 plates. (Ottawa: F. A. Acland.)

Berichte des Ohara Instituts für Landwirtschaftliche Forschungen in Kuraschiki, Provinz Okayama, Japan. By M. Kondō, Nōgaku-Kakuschi. Band 1, Heft 5. Pp. 519–628+plates 8–11. (Kuraschiki: Ohara Schōnōkai.) 2.80 yen.

Modern Methods of Welding as Applied to Workshop Practice. By J. H. Davies. Pp. xviii+263. (London: Constable and Co., Ltd.) 21*s*.

Laboratory Exercises in Applied Chemistry for Students in Technical Schools and Universities. By Dr. W. Moldenhauer. Authorised translation by Dr. L. Bradshaw. Pp. xii+236. (London: Constable and Co., Ltd.) 12*s*. 6*d*.

A History of the Association Psychology. By Prof. H. C. Warren. Pp. x+328. (London: Constable and Co., Ltd.) 16*s*.

Hydraulics of Pipe Lines. By Prof. W. F. Durand. (Glasgow Text-books of Civil Engineering.) Pp. xvi+271. (London: Constable and Co., Ltd.) 18*s*.

Fuel and Lubricating Oils for Diesel Engines. By W. Schenker. Pp. xii+114. (London: Constable and Co., Ltd.) 10*s*.

Principles and Practice of Business. By G. Mairet. (Life and Work Series.) Pp. xii+301. (London: Macmillan and Co., Ltd.) 5*s*

A First Book of Applied Electricity. By S. R. Roget. (First Books of Science Series.) Pp. viii+142. (London: Macmillan and Co., Ltd.) 2*s*. 6*d*.

The Autonomic Nervous System. By Prof. J. N. Langley. Part 1. Pp. viii+80. (Cambridge: W. Heffer and Sons, Ltd.) 5*s*. net.

A Concise Guide to the Town and University of Cambridge: In an Introduction and Four Walks. Originally written by Dr. J. W. Clark. Seventh edition, entirely revised. Pp. xx+199+map. (Cambridge: Bowes and Bowes.) 1*s*. 6*d*. net.

Oils, Fats, and Fuels. By Thomas Hull. Pp. viii+143. (London: Blackie and Son, Ltd.) 3*s*. 6*d*. net.

Agricultural Progress in Western India. By G. Keatinge. Pp. xii+253. (London: Longmans, Green and Co.) 6*s*. net.

Les Sciences et le Pluralisme. By J.-H. Rosny, aîné. (Nouvelle Collection scientifique.) Pp. iv+210. (Paris: F. Alcan.) 8 francs net.

Oil Shales. By Dr. H. B. Cronshaw. (Imperial Institute Monographs on Mineral Resources, with Special Reference to the British Empire.) Pp. x+80. (London: J. Murray.) 5*s*. net.

The Prevention of Malaria in the Federated Malay States: A Record of Twenty Years' Progress. By Dr. M. Watson and others. Second edition, revised and enlarged. Pp. xxviii+381. (London: J. Murray.) 36*s*. net.

Diary of Societies.

THURSDAY, DECEMBER 8.

ROYAL SOCIETY, at 4.30.—Lord Rayleigh: A Study of the Glow of Phosphorus, Periodic Luminosity, and Action of Inhibiting Substances (with experimental Demonstration).—Lord Rayleigh: The Aurora Line in the Spectrum of the Night Sky.—E. F. Armstrong and T. P. Hilditch: A Study of Catalytic Actions at Solid Surfaces. VII., The Influence of Pressure on the Rate of Hydrogenation of Liquids in Presence of Nickel.—W. D. Womersley: The Energy in Air, Steam, and Carbon Dioxide from 100° C. to 2000° C.—Lt.-Col. J. W. Gifford: Atmospheric Pressure and Refractive Indices, with a Corresponding Table of Indices of Optical Glass.—H. P. Waran: A New Form of Interferometer.—H. Harle: The Viscosities of the Hydrogen Halides.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Charles Ballance: A Glimpse into the History of the Surgery of the Brain (Thomas Vicary Lecture).

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. A. G. S. Mahomed: The Relation of Atmospheric Electrical Variations to the Incidence of Epileptic Fits.—Discussion on the Organisation of the Section.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—L. C. Martin: The Physical Meaning of Spherical Aberration.—Dr. F. Lloyd Hopwood: An Auto-stroboscope and an Incandescent Colour Top.—Lt.-Col. Gifford: Achromatic One Radius Doublet Eyepieces.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Prof. J. W. Gregory: The Genesis of Ores.

INSTITUTE OF METALS (London Section) (at 85 The Minories), at 8.—S. A. E. Wells: Casting in Metal Moulds.

ROYAL SOCIETY OF MEDICINE (Neurology Section) (at Hospital for Paralysis, Maida Vale), at 8.—Clinical Meeting.

CAMERA CLUB, at 8.15.—Capt. H. Lambart: The Intricacies of the Silent Drama and its Making.

HARVEIAN SOCIETY (at Medical Society of London), at 8.30.—Sir John Charlton Briscoe, Bart., Sir Sidney Russell Wells, Dr. G. H. Hunt, and Sir William Willcox: Discussion: Is the Anginal Syndrome only of Cardiac Origin?

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, DECEMBER 9

INSTITUTION OF WATER ENGINEERS (at Geological Society), at 10 a.m.—L. H. Lewis: The Manchester Water Works.—J. Don: Adsorption in Sand Filters.—C. F. Newton: Indicating and Recording Instruments.—P. B. Crosthwaite: The Louth Flood of 1920.—D. H. Thompson: Hydrological Conditions in the Chalk at Compton, West Sussex.—Discussion: The Final Report of the Water Power Resources Committee.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Prof J. H. Priestley and others: Discussion: The Resistance of the Normal and Injured Plant Surface to the Entry of Pathogenic Organisms.

JAPAN SOCIETY, at 5.—W. L. Schwartz: The Potters and Pottery of Satsuma.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—G. A. Sutherland and L. Clark: The Average Range of β-rays in Different Metals.—Prof. E. Wilson: The Sensitivity of Ballistic Galvanometers.—Prof. R. Ll. Jones: The Determination of the Damping Decrement of a Tuning Fork.—Dr. E. A. Owen: The Estimation of the Radium Content of Radio-active Luminous Compounds.

ROYAL ASTRONOMICAL SOCIETY, at 5.—W. M. H. Greaves: Certain Periodic Orbits in the restricted Problem of Three Bodies.—W. M. H. Greaves: Long-period Inequalities in the Movements of Asteroids of which the Mean Motions are nearly half that of Mars.—J. van der Bilt: Observations of Comets made with the 10-inch refractor of the University Observatory, Utrecht, Holland.—A. A. Nijland: Observations of Comet 1921*a* (Reid) made with the 10-inch refractor of the University Observatory, Utrecht, Holland.—Rev. T. G. R. Phillips: The Third Satellite of Jupiter.—Royal Observatory Greenwich: Mean Areas and Heliographic Latitudes of Sunspots in the year 1917.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Continuation of Discussion on Ball and Roller Bearings: Some Recent Types and Criticisms.

JUNIOR INSTITUTION OF ENGINEERS (at Royal United Service Institution), at 7.30.—C. H. Wordingham: Presidential address.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Dr. Carelli: Demonstration of a Method of Radioscopic Examination with the Help of Gas Injections.—Dr. Riddell: Demonstration of a Simple Apparatus for Making Serial Radiographs of Pyloric Region in the Horizontal and Upright Positions.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Clinical Evening.

SATURDAY, DECEMBER 10.

INSTITUTION OF WATER ENGINEERS (at Geological Society), at 10 a.m.—L. H. Lewis: The Manchester Water Works.—J. Don: Adsorption in Sand Filters.—C. F. Newton: Indicating and Recording Instruments.—P. B. Crosthwaite: The Louth Flood of 1920.—D. H. Thompson: Hydrological Conditions in the Chalk at Compton, West Sussex.—Discussion: The Final Report of the Water Power Resources Committee.

GILBERT WHITE FELLOWSHIP (at Lowther Lodge, Kensington Gore, S.W.7), at 2.30.

MONDAY, DECEMBER 12.

ROYAL BOTANIC SOCIETY OF LONDON, at 3.—Prof. A. W. Bickerton: Gardening (3): Artistic Gardening.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore, S.W.7), at 5.—Capt. J. B. L. Noel: Photographic Equipment and Methods for Travellers.
ROYAL SOCIETY OF ARTS, at 8.—A. M. Hind: Processes of Engraving and Etching (Cantor Lecture) (3).
SURVEYORS' INSTITUTION, at 8.—A. A. Hudson: The Relation of Soil to Plant Growth, and in Particular when Influenced by the Presence or Absence of Lime.

TUESDAY, DECEMBER 13.

ROYAL HORTICULTURAL SOCIETY, at 1.
EUGENICS EDUCATION SOCIETY (at Royal Society), at 5.—Prof. E. W. MacBride: The Inheritance of Acquired Characters and its Bearing on Eugenic Theory and Practice.
INSTITUTION OF CIVIL ENGINEERS, at 6.—E. Latham: Deep-water Quays: General Considerations of Design.—F. E. Wentworth-Shields: The Stability of Deep-water Quay-walls.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Technical Meeting.
QUEKETT MICROSCOPICAL CLUB, at 7.30.—T. E. Wallis: Microscopy as an aid to Analysis.
FARADAY SOCIETY (at Chemical Society), at 7.45.—Annual General Meeting.
CHEMICAL INDUSTRY CLUB AND LONDON SECTION OF SOCIETY OF CHEMICAL INDUSTRY (at Institution of Mechanical Engineers), at 8.—Cinematograph Films on the Winning and Working of Sulphur.—The Manufacture of Steel: Crucible, Open Hearth, Electric, and Bessemer Processes.—The Metallurgy of Zinc.
ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—W. J. Sandeman and others: Discussion: Progress in Gas Lighting in Relation to Illuminating Engineering.
FARADAY SOCIETY (at Chemical Society), at 8.15.—Prof. A. O. Rankine: The Structure of Gaseous Molecules.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—N. W. Thomas: The Week in West Africa.

WEDNESDAY, DECEMBER 14.

SOCIETY OF GLASS TECHNOLOGY (in Chemistry Lecture Theatre, University College), at 2.45.—V. Stott: Note on Pipettes.—A. J. Dalladay and F. Twyman: Measuring small variations of Refractive Index throughout Meltings of Optical Glass.—F. Twyman: The Annealing of Glassware, and Annealing without Pyrometers
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—H. J. Waring: The Operative Treatment of Malignant Disease: Its Possibilities and Limitations (Bradshaw Lecture).
ROYAL METEOROLOGICAL SOCIETY, at 5.—Discussion on Visibility, opened by F. J. W. Whipple: A general survey of the subject: Wing Commander M. G. Christie: from the Air Pilot's point of view; Captain Sir David Wilson-Barker: from the Seaman's point of view: Dr. J. S. Owens: London Fogs.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—H. F. L. Orcutt: Motor-car Gear Boxes.
ROYAL SOCIETY OF ARTS, at 8.—Sir Walter B. Townley: Trade with the Netherlands East Indies.

THURSDAY, DECEMBER 15.

LINNEAN SOCIETY OF LONDON, at 5
NEWCOMEN SOCIETY (at King's College, Strand, W.C.2), at 5.—Annual General Meeting.—At 5.15.—R. C. S. Walters: Greek and Roman Engineering Instruments.
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—J. H. Jeans: The New Dynamics of the Quantum Theory (Lecture). The following papers will be taken as read:—W. P. Milne: The Relations Between Apolarity and Clebsch's Mapping of the Cubic Surface in a Plane.—Miss G. D. Sadd: Certain Types of Plane Unicursal Curves.—H. M. Shaffer: The General Theory of Notational Relativity.—Pundit Oudh Upadhyaya: (1) Note on Gauss's Quadratic Identity; (2) A General Formula in Cubic Forms.—J. R. Wilton: Gibbs's Phenomenon in Fourier's Series and Integrals.
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—Discussion on Paper by H. F. Collins: The Igneous Rocks of the Province of Huelva and the Genesis of the Pyritic Orebodies.—A. V. Reis: Underground Working of Wide Pyritic Orebodies.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Capt. F. M. Green: Development of the Fighting Aeroplane.
CHILD STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss von Wyss: Vital Elements in Art Teaching.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—L. H. A. Carr: Induction-type Synchronous Motors.
CONCRETE INSTITUTE, at 7.30.—E. F. Sargeant: (*a*) The Preparation of Concrete Aggregates; (*b*) Moving Forms.
CHEMICAL SOCIETY, at 8.—G. T. Morgan and J. D. Main Smith: Researches on Residual Affinity and Co-ordination. Part VII., Cobaltic Lakes of the Alizarin Series.

FRIDAY, DECEMBER 16.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—G. Mitchell: Conveying and Elevating Machinery.—R. E. Knight: Discharge of Grain Cargoes in the Port of London by Pneumatic Elevators.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 8.—L. Richmond: Address.

SATURDAY, DECEMBER 17.

PHYSIOLOGICAL SOCIETY (at London Hospital).

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

THURSDAY, DECEMBER 8.

HOSPITAL FOR SICK CHILDREN (Gt. Ormond Street, W.C.1), at 4.—H. A. T. Fairbank: Coxa Vara.
UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudal Vestiges in America and Elsewhere (6).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (6).
KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (5).
ST. JOHN'S HOSPITAL (Leicester Square, W.C.2), at 6.—Dr. W. Griffith: Eczema (Chesterfield Lecture).
BARNES HALL (1 Wimpole Street, W.1), at 8.—Dr. C. Singer: The History of the Doctrine of Infection (Chadwick Lecture).

FRIDAY, DECEMBER 9.

UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (6).

SATURDAY, DECEMBER 10

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 10.30 a.m.—Prof. W. W. Watts: Geology as a Basis for Geography (Lectures for Teachers).

MONDAY, DECEMBER 12.

ROYAL COLLEGE OF SURGEONS, at 4.—F. W. Twort: Recent Researches on the Biology of Bacteria (Brown Lecture) (1).
KING'S COLLEGE, at 5.30.—H. Moore: Liquid Fuels (5)

TUESDAY, DECEMBER 13.

ROYAL COLLEGE OF SURGEONS, at 4.—F. W. Twort: Recent Researches on the Biology of Bacteria (Brown Lecture) (2).
KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (10).—Dr. W. Brown: Psychology and Psychotherapy (9).

WEDNESDAY, DECEMBER 14.

SCHOOL OF ORIENTAL STUDIES, at 5.—J. W. Gill: The Arab Intrusion into Bornu.

THURSDAY, DECEMBER 15.

ROYAL COLLEGE OF SURGEONS, at 4.—F. W. Twort: Recent Researches on the Biology of Bacteria (Brown Lecture) (3).
UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Religion and Feudalism (7).

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