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Chemical Disarmament

BY the British Draft Convention submitted to the Disarmament Conference at Geneva on March 16 by Mr. MacDonald, chemical, incendiary and bacterial warfare is prohibited on the lines already accepted by the Conference. It is therefore of particular interest now to consider the replies of the Pilotti Special Committee to a questionnaire on chemical, incendiary and bacterial weapons submitted to this Committee by the Bureau of the Disarmament Conference. The Special Committee's report* is an important document, and its study should assist to engender a sane and healthy opinion on an essential aspect of disarmament.

The most important feature of the Committee's report as a whole is the emphasis it places on the intricate relations of chemical warfare and chemical industry. It points out, for example, in one of its major conclusions, that the prohibition of the manufacture, import and possession of apparatus and substances exclusively used for chemical warfare, while possible, would only be of limited value. The manufacture of those substances which were of any importance in war could be improvised by any State possessing a chemical industry. "Any such prohibition imposed upon a State would either be ineffective in practice, in view of the stocks held in industrial establishments, or it would inflict irreparable damage on the chemical industry."

It will be recalled that, in "The Riddle of the Rhine", Major Lefebure asserted that grave disparity in the strength of the chemical industry of different countries constitutes a definite menace to world peace, and the Pilotti Committee may at first sight appear to be endorsing Major Lefebure's views and those shared by many others having expert knowledge of chemical industry. Actually, however, the views thus presented are much more negative and pessimistic than those of Major Lefebure, and we question whether they would find widespread support in professional circles.

No sensible man denies the intimate connexion of chemical industry and chemical warfare or the folly of attempting under the guise of chemical disarmament to impose a rigid and bureaucratic control on chemical industry. Equally, however, no sensible man would forget, as the Pilotti Committee appears to have done, that the main

* Chemical, Incendiary and Bacterial Weapons Special Committee. Conf. D. 152. League of Nations Publications Department. (9) Disarmament, 9, 65. (London: G. Allen and Unwin, Ltd., 1932.)

concern of chemical industry is with peaceful industry, that unlike the armaments industry, it has no interests vested in war, and that, as Major Lefebure insists, the existence of large stocks of war chemicals used in industry has no meaning for war unless the appropriate containers or chemical weapons have been designed and put into stock in corresponding quantities.

It is this preoccupation of chemical industry with peacetime activities, on which its expansion and development mainly depend, that constitutes not merely an obstacle to thorough-going chemical disarmament but indeed the best hope of a satisfactory solution. If due precautions are taken against the growth in this field of interests directly concerned with the encouragement or expansion of chemical warfare, chemical industry should continue to exert, not an influence unfavourable to disarmament, but a safeguard to the disarmed State in the readiness with which in emergency its resources could be improved for its defence.

The Pilotti Committee asserts, and rightly, that interference with the legitimate stocks of material held by chemical industry is unjustifiable and dangerous. It fails to observe, however, that, apart from the question of containers and apparatus raised by Major Lefebure, the magnitude of such stocks is limited by the internal demands of industry itself. No industry accumulates stocks of any material under normal conditions in excess of those required to meet its normal manufacturing and sales demands, and the prohibition of the holding of stocks of war chemicals by State departments, if observed in good faith, should effectively prevent the growth of a direct interest in chemical warfare as a regular outlet for the products of chemical industry.

The close relation of chemical warfare to chemical industry makes this question of control of stocks the critical one and almost the only point at which definite control can be considered. There is, for example, in some quarters much excited talk about prohibiting chemical or other research which might facilitate preparation for or developments in chemical warfare. The Pilotti Committee in its report administers an effective cold douche to such talk when it points out the danger of any such prohibition preventing also chemical and pharmacological research, which forms an essential element in the development of insecticides, fumigants and fungicides, seed disinfectants, antiseptics, medicinals and drugs. Man cannot afford to relax his efforts to overcome the forces of Nature and to combat the scourge of disease.

Nor is research on protective apparatus or appliances for the use of poisonous substances any easier to single out for restriction or repression. Industry itself is continuously demanding the improvement and much more widespread use of protective devices like the gas mask, and impediments to research in this field would be purchased dearly by human suffering in industry. Similarly, the apparatus used for producing fungicidal or insecticidal sprays when combating diseases of plants can also be used for creating clouds of poisonous substances in warfare. Certain types of fire-extinguisher can readily be converted into flame-projectors which are equally effective for military purposes or for destroying locusts.

The Committee emphasises, therefore, the limited value of prohibition of the preparation, importation, exportation and possession of substances exclusively suitable for chemical warfare, in view of the impracticability of prohibiting research on either poisonous substances or protective or offensive apparatus which are of industrial significance. It makes, however, a most significant omission, for the report contains no reference whatever to the *ad hoc* establishments maintained by governments for research on chemical warfare. This is the point on which the advocates of chemical disarmament are likely to seize. If research in this field is of such industrial importance as is claimed for it, the work is more fittingly and efficiently carried on in industry than in a government establishment, where attention is at least liable to be concentrated on the military rather than the industrial aspects. If we are told that such work cannot be carried out in industry, we are inclined to suspect its real value to humanity and to maintain that a general agreement to discontinue all State research on chemical warfare, defensive or offensive, would provide a highly desirable obstacle to the rapid improvisement of chemical warfare in the event of hostilities.

The silence of the Committee on this important point is disappointing but its importance can be overstressed. Without entering on a discussion as to whether or not chemical warfare is the most humane means of conducting warfare, if warfare we must have, the value of chemical disarmament by itself is insignificant. The Committee renders a real service in its consistent emphasis upon the relation of chemical disarmament to general disarmament. It points out, for example, that by far

the greater part of projectiles charged with poisonous substances in the War were projectiles of ordinary types; that it knows of no means of projection exclusively suitable for chemical warfare; ordinary guns may fire poisonous shells and ordinary aeroplanes transport receptacles filled with poisonous substances; and that these similarities destroy the practical value of any prohibition of training of armed forces in the use of chemical weapons. The troops are inevitably trained for chemical warfare in the normal course of their training.

The attempt to treat chemical warfare as a side issue is not only futile and misleading but may even have disastrous results. It can merely engender a false sense of security, and the major value of the Pilotti Committee's report lies in the convincing evidence it affords that chemical disarmament is only possible as part and parcel of a general and genuine disarmament scheme in every sphere. Given the good faith and genuine will to disarmament which is implicit in any such plan, chemical disarmament appears to present no real obstacle to progress, and could be effected without endangering security. While it is true, as the Committee observes, that the existence of an important chemical industry in any country permits the rapid improvisation and organisation of chemical warfare even when no special preparation has been made in peace time, the installation or adaptation and starting up of the manufacture of the necessary toxic materials on a large scale require a certain time, and this lag affords the check that is the essence of real disarmament.

The ease with which chemical industry can divert its energies to the production of munitions of war, whether in the sense of high explosives or chemical weapons, should not be allowed to obscure the fact that a definite time lag does in fact exist. The fundamental question is whether our national or international system is to be organised for peace or for war. If the answer is peace, the mere existence of widespread chemical industry preoccupied with the legitimate interests of commerce and industry, tempted by no outlets for its products for offensive purposes, offers a safeguard rather than a menace to the world, so long as that peace is organised and kept. The distribution of natural resources and chemical industry in the world is such as to ensure that any transgressor State must be in a position of technical inferiority to collective reprisals from the rest of the world.

The Pilotti Committee has prepared a report which, while of unequal merit, contrives to make certain essential points beyond question—chemical disarmament is not a matter to be discussed apart from the general question of disarmament, and no restrictions can be devised which, if mankind is so foolish as to perpetuate the present armed peace, can be effective to prevent the liberation of the destructive and terrifying forces of chemical warfare.

Innermost Asia

On Ancient Central-Asian Tracks: Brief Narrative of Three Expeditions in Innermost Asia and North-Western China. By Sir Aurel Stein. Pp. xxiv+342+102 plates. (London: Macmillan and Co., Ltd., 1933.) 31*s.* 6*d.* net.

IT is just on a third of a century ago that Sir Aurel Stein began his exploration of 'innermost Asia'. By 1916 he had covered, on horse and foot, a distance in the aggregate of 25,000 miles in the course of three expeditions to Chinese Turkistan—the first in 1900–1, the second in 1906–8 and the third in 1913–16. It will be fresh in the memory of all that a fourth journey begun in 1930 proved abortive owing to the difficult attitude of Chinese authority.

The mere extent of the ground covered in these three expeditions, great as it may seem with such primitive means of transport—camel, pony and man—as alone were available, is but an imperfect gauge of Sir Aurel's achievement. The greatest powers of endurance and tenacity of purpose were needed to carry it through, in face of the trying climatic and geographical conditions. The discovery and excavation of these long-forgotten desert sites could be carried on only in winter. In part this was due to the heat of the summers, in part owing to the difficulty of transporting water in the desert in any form but that of blocks of ice. It is not surprising that the workmen were unable to endure more than a comparatively short period of continuous labour when exposed to the icy, sand-laden winds in a temperature that hovered normally somewhere about zero. It was in such conditions that Sir Aurel Stein secured a mass of geographical and topographical data and of archæological material which has enabled him to revive, like a palimpsest, a long and important forgotten chapter, or rather series of chapters, in the history of civilisations.

The results of Sir Aurel Stein's journeys in

Chinese Turkistan and the adjacent areas have already been made known to the scientific world in a series of carefully documented reports and in two volumes containing his personal narrative. Of the latter, one is out of print; of the former, those which are not out of print, if only on account of their cost, are beyond the reach of the ordinary individual. In the volume now before us, Sir Aurel has compiled a personal narrative which forms a composite picture. In this, ignoring chronological order, he conducts his readers over the whole of the ground traversed in geographical sequence, and describes in sufficient detail each of the sites excavated as well as the principal results. He has in this manner made the complete circuit of Chinese Turkistan, with a detour into China proper, starting from Kashmir and returning along the foot of the T'ien Shan on the northern boundary to cross the Pamirs. The wider public to whom this personal narrative will be accessible owes the author a debt of gratitude that, amid the labours and disappointments of the last few years, he should have had the courage and energy to prepare and see through the press a work which will admit them to an intimate view of his great achievement.

The scientific results—topographical, geographical and archæological—of the three journeys were remarkable. They are too extensive for even bare enumeration here; but it may not be out of place to note one or two of the more outstanding. Much unsurveyed country was mapped—in the Nan-shan ranges alone some 24,000 miles were covered by plane-table—and much unexplored country was crossed, this more particularly on the northern boundary, a journey which was illuminating in the light it threw on the activities of the Mongols. No less interesting were the historico-topographical results, especially in the ancient Lou-Lan, by which were verified the records of early Chinese travellers and of the Imperial annals. They fully bear out the evidence which had made this desert the great artery joining China to the West, and showed that it had been held in turn by garrisons of Chinese, Indo-Scythians, and Tibetans, as well as the later Huns, Turks and the great Manchu emperors of China in the eighteenth century.

One of the problems upon which Sir Aurel's investigation has an important bearing is that of the causes which have led to the destruction of these sand-buried cities and the disappearance of the oases of the Tarim basin in which they stood. He holds the view that the evidence does not point to any continuous and progressive desiccation due to climatic variation, such as has been postulated; climatic conditions evidently have remained unchanged for centuries. It would appear that fertility depended upon irrigation, which became disorganised in unsettled political conditions and thus allowed desert conditions to prevail once more. On the other hand, he accepts the hypothesis that shrinkage of the glacier-fed rivers, which now makes any revival of fertility impossible, may be due to the gradual disappearance of the 'fossil' ice left from glaciations of the Ice Age.

In archæology, the thrills of discovery abound. From the first find of Buddhist art in Khotan—the first indication of the all-pervading influence of Western art, Iranian, Greek, Græco-Buddhist, in the Tarim basin and beyond—and the clay-sealed wooden documents at Niya, the interest rises until it culminates in the revelations of the store-chamber in a cave-temple in the oasis of Tun-Huang, in which were early Chinese, Buddhist and other writings and Buddhist paintings on silk of the T'ang period. Of these a rich store ultimately found a resting place in the British Museum. They have provided a mine for the delving of scholars over a long period of years and are still not exhausted. The wooden official documents, of which some of the sealings are pure Greek in subject, have been found to contain the earliest known examples of the Indian Karoshthi script, dating from the early centuries of our era; while among the documents from Tun-Huang are languages previously unknown, one of them, Tokharian, an Aryan language, which exhibits the anomalous feature that its affinities are with the western group of those languages, rather than with the eastern.

It is clear from internal evidence that Sir Aurel's expeditions were brought to a successful end only by the most careful organisation. This serves to emphasise a fact which is inevitably borne upon the reader of his book. The great Chinese expedition to Farghana of an army of 60,000 men, of whom 30,000 were successfully brought across the desert, under the Han dynasty, the maintenance of a system of desert forts, and the building of a protective wall, of which Sir Aurel traced the course for four hundred miles from the Su-lo-ho basin to the Etsin-gol, all bear witness to the organising ability and powers of recuperation of the Chinese. It seems to afford some justification for those of them who now regard the present

situation, which for any other people might be looked upon as crushing, as no more than a phase which will pass.

It is no exaggeration to say that Sir Aurel Stein's record will rank with the great books of travel. In point of style it contains what is probably his best work. A restrained but vivid narrative sustains its interest from the first page to the last. No little praise is due to his publishers, who evidently have spared no pains to give his story a worthy setting. Few if any books of travel and archæological exploration have been more liberally and adequately illustrated, while the reproductions in colour of Buddhist paintings deserve the highest commendation.

Old Wine and New Bottles

A Text-Book of Physical Chemistry. By Dr. J. Newton Friend. (Griffin's Scientific Text-Books.) Vol. 1: *General Properties of Elements and Compounds.* Pp. xii+501. (London: Charles Griffin and Co., Ltd., 1932.) 24*s.* net.

"WENT to the Royal Institution last night in hopes of hearing Faraday lecture, but the lecture was given by Mr. Pereira upon crystals, a subject of which he appeared to be master, to judge by his facility and fluency. . . . Met Dr. Buckland and talked to him for an hour, and he introduced me to Mr. Wheatstone, the inventor of the electric telegraph. . . . There is a cheerfulness, an activity, an appearance of satisfaction in the conversation and demeanour of scientific men that conveys a lively notion of the *pleasure* they derive from their pursuits."

Thus far the author of the Greville memoirs under date March 17, 1838.

Nearly a century has passed, and a modern lecture on crystals, still most appropriately given at the lecture table of the Institution, would reveal secrets of atomic structure far transcending the scope of the discourse of the learned Dr. Jonathan Pereira; nevertheless, our men of science bear very lightly the vast weight of a century's accumulated knowledge, and cheerfulness and activity still dominate the conversations of the Royal Institution.

They who work on border-line subjects may be expected to feel most heavily the pressure of this accumulation. The physical chemist of to-day has to be both physicist and mathematician, at home with the developments of quantum theory, and competent to handle the theorems of statistical mechanics. Withal, there is scarcely anything of the older knowledge which he can afford to shed, and it will be an ill day for him when he loses the outlook peculiar to the chemist. The phase rule and Le Chatelier's theorem are weapons as potent as ever they were; and the skilled chemist must have at command much detailed knowledge of thermal and optical quantities, of surface and viscous forces, of equations of state and kinetic theory; in short, he must be well acquainted with the topics discussed in the first volume of Dr. Newton Friend's treatise, and with much besides.

In a brief review, it is impossible to do more than to summarise the headings of the twenty-two chapters which the book comprises—elementary kinetic theory, vapour pressure, critical phenomena and gas liquefaction, change of state, volume relations, the crystalline state, viscosity, surface tension, optical properties, solubility, diffusion, osmosis, adsorption and the colloidal state are chief among the properties dealt with in this first volume.

It is significant that, with such a list of subjects under review, the general index to the volume contains no entry under the heading 'quantum', nor are the names Debye, Einstein and Bragg listed. It must be said emphatically that this remark is not made by way of criticism—it serves merely to show that, in this volume at least, the author is concerned to deal with that mass of basic older knowledge with which every chemist may be expected to be conversant.

The treatment of these topics is, within the limits indicated, fairly full, though on the whole elementary in outlook. It would surely save time and trouble if, for example, the 'equal-root' method of deducing the critical constants in terms of those of the equation of state were abandoned for the more general method which involves writing down the analytical condition for a point of inflexion with a horizontal tangent. Not every equation of state is a cubic equation.

Two minor points may be noted. In the diagram on p. 99 representing the law of rectilinear diameters, the diameter is surely sloping the wrong way (compare van't Hoff, "Vorlesungen", vol. 3, p. 19). Again (p. 262), we read that the general relation connecting surface tension and temperature is

$$\sigma = \sigma_0 (1 - \alpha t + \beta t^2),$$

which it certainly is not.

The remaining volumes of Dr. Friend's treatise will be awaited with interest.

ALLAN FERGUSON.

Cantor: the Mathematician of the Infinite

Georg Cantor Gesammelte Abhandlungen: Mathematischen und philosophischen Inhalts mit erläuternden Anmerkungen sowie mit Ergänzungen aus dem Briefwechsel Cantor-Dedekind. Herausgegeben von Ernst Zermelo. Nebst einem Lebenslauf Cantors von Adolf Fraenkel. Pp. vii + 486. (Berlin: Julius Springer, 1932.) 48 gold marks.

"INFINITY," wrote the schoolboy, "is the place where things happen that don't." Similar opinions concerning the paradoxes which arise from the consideration of the infinite and the infinitesimal have been expressed for more than two thousand years. About 450 B.C., Zeno put forward four such paradoxes, of which the best known is "Achilles and the Tortoise". In the seventeenth and eighteenth centuries infinity and the infinitesimal were used very recklessly, and when at last mathematicians sought to return to the Greek standard of accuracy, they were unanimous in rejecting the use of infinity as something completed. But what all had rejected Cantor chose as his foundation stone.

Georg Cantor was born in 1845 at St. Petersburg, the son of a Dane. Georg soon showed an intense interest in mathematics, but was compelled to study engineering. His love for mathematics continued, and his father at last agreed that he should devote himself to it. In 1863 he went to Berlin, where Kummer, Weierstrass and Kronecker were professors. He obtained his Ph.D. degree in 1867, and one of his theses was that "in mathematics it is more important to state a question properly than to solve it". Actually the great importance of his later work lay more in the ideas and notation than in the actual results. In 1869 he became *privatdozent* at Halle, afterwards obtaining a professorship. In 1872 he produced his well-known theory of irrational numbers, published about the same time as the similar theories of Méray, Weierstrass and Dedekind, who share the credit of clearing up difficulties that had lasted from the time of the Greeks.

Cantor will be for ever famous as the creator of the theory of aggregates. This met with much opposition, especially from Kronecker, to whom Cantor's 'actual infinity' seemed a gratuitous return to the old errors which had corrupted mathematics for so long. Cantor was deeply distressed by this opposition, and in 1884 he suffered a mental breakdown, which recurred from time to time up to his death in 1918.

Some of Cantor's ideas can be understood by those with no knowledge of mathematics. In what follows some modifications due to Hobson have been incorporated. Consider the positive integers, 1, 2, 3 . . . This is an example of an *infinite aggregate*, which has the special property of being *simply ordered*; that is, given any two elements, we can tell which comes before the other. It has the further property of having a first element, and every other aggregate formed by taking part of the whole has the same property. Such aggregates are called *well-ordered*. A second simply ordered infinite aggregate that is also well-ordered is given by the even positive integers, 2, 4, 6 . . . These two aggregates are said to be *equivalent*, that is, there is a one-to-one correspondence between the elements of each, so the whole is equivalent to its part! In this case the equivalence is of a special kind known as *similarity*, that is, the corresponding elements occur in the same order. All simply ordered aggregates which are similar to one another are said to have the same *order-type*. The order-type of our first example, and so also of our second, is denoted by ω. The order-type of a well-ordered aggregate is called its *ordinal number*, so ω is a *transfinite* ordinal number.

A third aggregate, of a different kind, is formed by the positive rational numbers, for example, two-sevenths, three-fifths. If the elements are arranged in order of magnitude the aggregate is simply ordered, as we can tell which of two numbers is the smaller, but not well-ordered, as there is no first term, for given any rational number we can find a smaller one; the aggregate is *everywhere dense*, that is, given any two rational numbers, we can find others lying between them. This aggregate is not similar to the first or second, but let us re-arrange it as follows:

$$\frac{1}{1}\,;\ \frac{1}{2}\,,\ \frac{2}{1}\,;\ \frac{1}{3}\,,\ \frac{3}{1}\,;\ \frac{1}{4}\,,\ \frac{2}{3}\,,\ \frac{3}{2}\,,\ \frac{4}{1}\,;\ \ldots$$

so that the sum of the numerator and denominator is 2, 3, 4 . . . in the first, second, third . . . group; each group contains a finite number of elements, arranged in order of magnitude. This fourth aggregate is simply ordered and well-ordered; it is also similar to our first and second. The third is equivalent to the others, but not similar to them.

Aggregates which are equivalent are said to have the same *power* or *cardinal number*. Aggregates equivalent to our first are called *enumerable*,

and their cardinal number is denoted by a or by *Alef-zero*. Cantor's first great discovery was that the aggregate of all real algebraic numbers, that is, the real roots of algebraic equations with integral coefficients, is enumerable, but the aggregate of *all* real numbers (including non-algebraic irrationals such as π and e) is not. The cardinal number of the latter aggregate is called the *power of the continuum*, and is denoted by c. It corresponds to the infinite set of points in either a finite or infinite straight line, and, strange to say, also to those in a square or cube. The attempt to find cardinal numbers greater than c leads to the general theory of transfinite numbers.

Burali-Forti's discovery in 1897 (anticipated by Cantor in 1895) that the theory of transfinite ordinal numbers led to a paradox, started a controversy that is not yet settled. Some say, with Poincaré, "There is no actual infinity. The Cantorians have forgotten this and so have fallen into contradiction." Others, such as Zermelo, believe that Cantor's work, although defective as it stands, can be made sound by the explicit postulation of a suitable set of axioms, but no such set has yet been universally accepted. Many consider that some of Cantor's definitions, which do not tell us how to construct the entities in question, contain latent self-contradictions. Whatever view is taken on these questions, Cantor's more elementary ideas have become indispensable in the exact formulation of results in analysis and geometry.

H. T. H. PIAGGIO.

Short Reviews

Physical Chemistry. By Prof. Dr. John Eggert. Translated by Dr. S. J. Gregg. A translation of the third edition of "Lehrbuch der physikalischen Chemie" revised in collaboration with Prof. Dr. Lothar Hock. Pp. xi + 632. (London: Constable and Co., Ltd., 1932.) 24*s*. net.

THE third edition of Prof. Eggert's "Physical Chemistry" has been translated by Dr. Gregg, of King's College, London. The book is divided into three parts. The first part on "Atomics and Energetics" includes sections on classical chemical theory, thermodynamics, kinetic theory and quantum theory, all treated very briefly in about eighty pages. The second part, on "The Nature of Matter", occupying about 230 pages, is divided into three main sections, atoms, molecules and states of aggregation. The third part, on "Chemical Reactions" which occupies the remaining half of the book, has five main sections, on chemical equilibrium, thermochemistry, electrochemistry, chemical kinetics and photochemistry.

In general, Prof. Eggert's book deals only briefly with the topics which were taught under the name of physical chemistry during the pre-War period; but it describes much more fully the themes which have been developed during the subsequent years. There are thus ample references to electrons, isotopes, atomic and molecular spectra, crystal lattices, strong electrolytes, activity coefficients, active molecules and chain reactions, whilst the properties of dilute aqueous solutions and the theory of electrolytic dissociation no longer occupy the predominant position which was given to them in earlier textbooks. This change of emphasis corresponds with the liberation of physical chemistry from the limitations of the preceding decades; and the wide outlook of the present volume is an indication of the debt which chemists owe to an inrush of sound physics into their science.

The English version of Prof. Eggert's book may indeed be welcomed because it presents a readable and attractive account of the 'chemical physics' by which the rudimentary 'physical chemistry' of the preceding generation has now been so largely replaced.

A Textbook of Pharmacognosy. By J. W. Cooper and T. C. Denston; with Illustrations and Drawing Notes by M. Riley. Pp. x + 298. (London: Sir Isaac Pitman and Sons, Ltd., 1931.) 10*s*. 6*d*. net.

ALTHOUGH the title of this book is a little misleading—it should surely have been "A Textbook of Practical Pharmacognosy", according to the very principle laid down in the authors' preface—its use will probably extend well beyond the circle of students for whom it is primarily intended. In that sense, it may well act as a substitute for larger works of reference on the shelves of those who have only occasionally to tackle the description and identification of natural drugs.

For these, however, the purely haphazard arrangement of plant families, varying in the different sections (occasionally even two representatives of one family occur in different places in the same section), is a disadvantage only partly set off by a good index. Surely some standard arrangement, such as that of Bentham and Hooker, could have been used throughout. The drawings, on the other hand, should be of good service to users of the book, though a few that have been omitted might well be included (for example, *Chiretta*, for comparison with *Lobelia*).

The tests described are comprehensive and well explained, even if the advertisement of a particular brand of malt extract (p. 4) seems a little gratuitous; there are plenty of other diastatic extracts on the market. Print and binding are of the quality that a reference book needs—simple, clear and durable.

A. L. B.

Elementary Trigonometry. By Dr. John Prescott and H. V. Lowry. Pp. xi+444. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1932.) 5*s*.

IN this volume the authors "have tried to recapture the spirit of some of the writers of a few generations ago who looked on Trigonometry as a branch of applied rather than of pure mathematics". The course mapped out is therefore different in many ways from that found in most other textbooks. Great stress is laid on "the kind of calculations and manipulations of trigonometric expressions that occur in the applications of the subject". Theory is not neglected, but it only enters where it is necessary to establish practical formulæ. The scope is fairly wide and includes an excellent section on mensuration and solid geometry. A welcome feature is the introduction of radian measure at the beginning.

Cartesian geometry is freely used in establishing many of the standard theorems, and special attention is given to graphs and their uses. A novel feature is the addition of an appendix in which is discussed a geometrical method of calculating π to any degree of accuracy without using trigonometry.

Whilst many teachers may not agree with the general treatment, yet they will find much to stimulate interest together with a good selection of exercises, many of which are of an unusual type.

General Science. By F. Fairbrother and E. Nightingale. Part 1. Pp. viii+136. (London: G. Bell and Sons, Ltd., 1932.) 2*s*. 3*d*.

GENERAL agreement is now reached upon the importance of giving all normal pupils in all schools some instruction in the nature of the environment in which their lives must be spent. For this purpose courses have to be planned which shall give the elements of physics, chemistry, biology, geology and astronomy. Until much more experience has been gained there is likely to be great diversity in such proposed courses.

The physical and chemical parts proposed by Fairbrother and Nightingale begin with experiments on the Bunsen burner, combustion, distillation and crystallisation. Then follows the measurement of length, area, volume and density and experiments on buoyancy and flotation. Thermal expansion, thermometry, pressure in liquids and in the atmosphere and the chemistry of the air complete the first part of the course, which is well illustrated by clear diagrams and everyday applications.

At present the value of any course in general science can be assessed only by the user—so much depends upon the teacher—and it is to be hoped that bold experimentation in the choice and treatment of topics will not be cramped by external examination systems and will lead to the production of many books of a standard similar to the present one.

An Introduction to Organic Chemistry. By Prof. Ira D. Garard. Pp. ix+296. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1932.) 16*s*. 6*d*. net.

THIS is an expensive introduction to organic chemistry, which does not offer any particularly novel features. The type of treatment is indicated by the first few chapter headings, which run as follows: introduction, methane and related compounds, alcohols and ethers, halogen derivatives of the paraffins, unsaturated hydrocarbons, aldehydes and ketones. The descriptive work is well done, and the accompanying graphic formulæ are set out very clearly. Some of the space devoted to the accounts of individual substances might have been used to greater advantage in a fuller exposition of such general matters as the fundamental principles of stereochemistry and the nature of cyclic compounds. Thus, the constitutions of quinoline, isoquinoline, and more complex heterocyclic substances are presented without explanation before benzene has been discussed; and even when benzene is reached, its constitution receives scant attention. The final chapter contains laboratory directions for twenty-eight simple experiments in organic chemistry. The book contains fifteen diagrams, mostly of apparatus.

Foundations and Methods of Chemical Analysis by the Emission Spectrum. Being the authorised translation of "Die chemische Emissionsspektralanalyse" by Dr. Walther Gerlach and Dr. Eugen Schweitzer. Pp. 123. (London: Adam Hilger, Ltd., n.d.) 12*s*. 6*d*. net.

To a large extent this book consists of a summary of original researches carried out by the joint authors and published in the *Zeitschrift für anorganische und allgemeine Chemie*. It affords an authoritative account of the principles and practice of spectrographic analysis, and there are chapters dealing with the electrical and optical apparatus used in analysis by the emission spectrum, qualitative analysis, quantitative analysis, experiments on the refinement of the method by photometric intensity measurements, and special problems. Many of the points here presented have hitherto appeared only in the periodical literature. The book is well printed and illustrated, and it will be found helpful and suggestive to all who are interested in spectrographic methods.

An Agricultural Atlas of England and Wales. Second edition, revised. Made on behalf of the Agricultural Economics Research Institute, University of Oxford, by Malcolm Messer. Published by direction of the Ministry of Agriculture and Fisheries. Pp. iv+25+3 maps. (Southampton: Ordnance Survey Office, 1932.) 10*s*. net.

THE present re-issue of this atlas is based on the agricultural returns for 1928. The area of each map now includes the Channel Islands and additional maps show the distribution of agricultural labour, sugar-beet and poultry.

Light and Life*

By PROF. N. BOHR, For.Mem.R.S.

AS a physicist whose studies are limited to the properties of inanimate bodies, it is not without hesitation that I have accepted the kind invitation to address this assembly of scientific men met together to forward our knowledge of the beneficial effects of light in the cure of diseases. Unable as I am to contribute to this beautiful branch of science that is so important for the welfare of mankind, I could at most comment on the purely inorganic light phenomena which have exerted a special attraction for physicists throughout the ages, not least owing to the fact that light is our principal tool of observation. I have thought, however, that on this occasion it might perhaps be of interest, in connexion with such comments, to enter on the problem of what significance the results reached in the limited domain of physics may have for our views on the position of living organisms in the realm of natural science.

Notwithstanding the subtle character of the riddles of life, this problem has presented itself at every stage of science, since any scientific explanation necessarily must consist in reducing the description of more complex phenomena to that of simpler ones. At the moment, however, the unsuspected discovery of an essential limitation of the mechanical description of natural phenomena, revealed by the recent development of the atomic theory, has lent new interest to the old problem. This limitation was, in fact, first recognised through a thorough study of the interaction between light and material bodies, which disclosed features that cannot be brought into conformity with the demands hitherto made to a physical explanation. As I shall endeavour to show, the efforts of physicists to master this situation resemble in some way the attitude which biologists more or less intuitively have taken towards the aspects of life. Still, I wish to stress at once that it is only in this formal respect that light, which is perhaps the least complex of all physical phenomena, exhibits an analogy to life, the diversity of which is far beyond the grasp of scientific analysis.

From a physical point of view, light may be defined as the transmission of energy between material bodies at a distance. As is well known, such an energy transfer finds a simple explanation in the electromagnetic theory, which may be regarded as a direct extension of classical mechanics compromising between action at a distance and contact forces. According to this theory, light is described as coupled electric and magnetic oscillations which differ from the ordinary electromagnetic waves used in radio transmission only by their greater frequency of vibration and smaller wave-length. In fact, the practically rectilinear propagation of light, on which rests our location of bodies by direct vision or by suitable optical instruments, depends entirely on the smallness of the wave-length compared with the dimensions of the bodies concerned, and of the instruments.

The idea of the wave nature of light, however, not only forms the basis for our explanation of the colour phenomena, which in spectroscopy have yielded such important information of the inner constitution of matter, but is also of essential importance for every detailed analysis of optical phenomena. As a typical example, I need only mention the interference patterns which appear when light from one source can travel to a screen along two different paths. In such a case, we find that the effects which would be produced by the separate light beams are strengthened at those points on the screen where the phases of the two wave trains coincide, that is, where the electric and magnetic oscillations in the two beams have the same directions, while the effects are weakened and may even disappear at points where these oscillations have opposite directions, and where the two wave trains are said to be out of phase with one another. These interference patterns have made possible such a thorough test of the wave nature of the propagation of light, that this conception can no longer be considered as a hypothesis in the usual sense of this word, but may rather be regarded as an indispensable element in the description of the phenomena observed.

As is well known, the problem of the nature of light has, nevertheless, been subjected to renewed discussion in recent years, as a result of the discovery of a peculiar atomistic feature in the energy transmission which is quite unintelligible from the point of view of the electromagnetic theory. It has turned out, in fact, that all effects of light may be traced down to individual processes, in each of which a so-called light quantum is exchanged, the energy of which is equal to the product of the frequency of the electromagnetic oscillations and the universal quantum of action, or Planck's constant. The striking contrast between this atomicity of the light phenomena and the continuity of the energy transfer according to the electromagnetic theory places us before a dilemma of a character hitherto unknown in physics. For, in spite of the obvious insufficiency of the wave picture, there can be no question of replacing it by any other picture of light propagation depending on ordinary mechanical ideas.

Especially, it should be emphasised that the introduction of the concept of light quanta in no way means a return to the old idea of material

* Address delivered at the opening meeting of the International Congress on Light Therapy, Copenhagen, on August 15, 1932. The present article, conforming with the Danish version (*Naturens Verden*, **17**, 49), differs from that published in the Congress report only by some formal alterations.

particles with well-defined paths as the carriers of the light energy. In fact, it is characteristic of all the phenomena of light, in the description of which the wave picture plays an essential rôle, that any attempt to trace the paths of the individual light quanta would disturb the very phenomenon under investigation; just as an interference pattern would completely disappear, if, in order to make sure that the light energy travelled only along one of the two paths between the source and the screen, we should introduce a non-transparent body into one of the paths. The spatial continuity of light propagation, on one hand, and the atomicity of the light effects, on the other hand, must, therefore, be considered as complementary aspects of one reality, in the sense that each expresses an important feature of the phenomena of light, which, although irreconcilable from a mechanical point of view, can never be in direct contradiction, since a closer analysis of one or the other feature in mechanical terms would demand mutually exclusive experimental arrangements.

At the same time, this very situation forces us to renounce a complete causal description of the phenomena of light and to be content with probability calculations, based on the fact that the electromagnetic description of energy transfer by light remains valid in a statistical sense. Such calculations form a typical application of the so-called correspondence argument, which expresses our endeavour, by means of a suitably limited use of mechanical and electromagnetic concepts, to obtain a statistical description of the atomic phenomena that appears as a rational generalisation of the classical physical theories, in spite of the fact that the quantum of action from their point of view must be considered as an irrationality.

At first sight, this situation might appear very deplorable; but, as has often happened in the history of science, when new discoveries have revealed an essential limitation of ideas the universal applicability of which had never been disputed, we have been rewarded by getting a wider view and a greater power of correlating phenomena which before might even have appeared as contradictory. Thus, the strange limitation of classical mechanics, symbolised by the quantum of action, has given us a clue to an understanding of the peculiar stability of atoms which forms a basic assumption in the mechanical description of any natural phenomenon. The recognition that the indivisibility of atoms cannot be understood in mechanical terms has always characterised the atomic theory, to be sure; and this fact is not essentially altered, although the development of physics has replaced the indivisible atoms by the elementary electric particles, electrons and atomic nuclei, of which the atoms of the elements as well as the molecules of the chemical compounds are now supposed to consist.

However, it is not to the question of the intrinsic stability of these elementary particles that I am here referring, but to the problem of the required stability of the structures composed of them. As a matter of fact, the very possibility of a continuous transfer of energy, which marks both the classical mechanics and the electromagnetic theory, cannot be reconciled with an explanation of the characteristic properties of the elements and the compounds. Indeed, the classical theories do not even allow us to explain the existence of rigid bodies, on which all measurements made for the purpose of ordering phenomena in space and time ultimately rest. However, in connexion with the discovery of the quantum of action, we have learned that every change in the energy of an atom or a molecule must be considered as an individual process, in which the atom goes over from one of its so-called stationary states to another. Moreover, since just one light quantum appears or disappears in a transition process by which light is emitted or absorbed by an atom, we are able by means of spectroscopic observations to measure directly the energy of each of these stationary states. The information thus derived has been most instructively corroborated also by the study of the energy exchanges which take place in atomic collisions and in chemical reactions.

In recent years, a remarkable development of the atomic theory has taken place, which has given us such adequate methods of computing the energy values for the stationary states, and also the probabilities of the transition processes, that our account, on the lines of the correspondence argument, of the properties of atoms as regards completeness and self-consistency scarcely falls short of the explanation of astronomical observations offered by Newtonian mechanics. Although the rational treatment of the problems of atomic mechanics was possible only after the introduction of new symbolic artifices, the lesson taught us by the analysis of the phenomena of light is still of decisive importance for our estimation of this development. Thus, an unambiguous use of the concept of a stationary state is complementary to a mechanical analysis of intra-atomic motions; in a similar way the idea of light quanta is complementary to the electromagnetic theory of radiation. Indeed, any attempt to trace the detailed course of the transition process would involve an uncontrollable exchange of energy between the atom and the measuring instruments, which would completely disturb the very energy transfer we set out to investigate.

A causal description in the classical sense is possible only in such cases where the action involved is large compared with the quantum of action, and where, therefore, a subdivision of the phenomena is possible without disturbing them essentially. If this condition is not fulfilled, we cannot disregard the interaction between the measuring instruments and the object under investigation, and we must especially take into consideration that the various measurements required for a complete mechanical description may only be made with mutually exclusive experimental arrangements.

In order fully to understand this fundamental limitation of the mechanical analysis of atomic phenomena, one must realise clearly, further, that in a physical measurement it is never possible to take the interaction between object and measuring instruments directly into account. For the instruments cannot be included in the investigation while they are serving as means of observation. As the concept of general relativity expresses the essential dependence of physical phenomena on the frame of reference used for their co-ordination in space and time, so does the notion of complementarity serve to symbolise the fundamental limitation, met with in atomic physics, of our ingrained idea of phenomena as existing independently of the means by which they are observed.

(*To be continued.*)

Phases in South African Locusts

THE theory of phase variation in swarming locusts was first put forward about ten years ago, since when a considerable amount of data has been accumulated in its support. Most of the evidence, however, was either based on direct field observations, or on small-scale experiments which served only to prove the fact of the transformation from the solitary to the gregarious phase, and vice versa, but were insufficient for analytical study of the phenomenon and of its underlying causes. This gap has now been filled by a paper by Prof. J. C. Faure recording the results of four years' experimental studies on the phases of four species of locusts occurring in South Africa.*

The bulk of the experiments refer to the well-known brown locust of South Africa (*Locustana pardalina*, Wlk.), and most of them were repeated on the tropical migratory locust (*Locusta migratoria migratorioides*, R. and F.) which swarmed over enormous areas of the African continent last year; some corroboration of the results was obtained also from studies on the desert locust (*Schistocerca gregaria*, Forsk.) and the red locust (*Nomadacris septemfasciata*, Serv.).

The main result of the numerous breeding experiments made under a great variety of conditions is a final proof that the phase transformation is a scientific fact which can no longer be doubted. Indeed, Prof. Faure succeeded in producing the swarming phase from the solitary one, and vice versa, in the case of every species experimented upon.

Turning to the problem of the mechanism and the causes of the transformation, Prof. Faure's experiments confirm beyond doubt the importance of the density of the population in a given space. Locusts raised in crowded cages invariably assume the colour and structural characters of the swarming phase, and those kept in isolation become typical of the solitary phase. The factor responsible for the transformation appears to be the greater activity on the part of locusts in crowded cages, where every movement of an individual disturbs the others and the mutual excitation practically never dies down. This excessive activity results in an abnormally high rate of metabolism, and the striking reddish (or yellow) and black coloration of the hoppers of the swarming phase may be ascribed to the deposition in the chitin of some products of this abnormal metabolism; these unknown products are called 'locustine' by Prof. Faure. Structural differences by which the two phases can be separated may be explained also as a result of greater development of certain muscles in gregarious hoppers as compared with the solitary ones. This theory was tested in a series of experiments in which hoppers kept in isolation were forced to excessive activity, but unfortunately this proved to be a very difficult task, since none of the several very ingenious methods of stimulation applied to hoppers produced the desired degree of activity. Nevertheless, the results show clearly that a change towards the gregarious phase occurs in isolated but active hoppers, and there remains little doubt that solitary hoppers if forced to lead an excessively active life would produce a locust of the swarming phase.

A supplementary factor of the transformation is temperature, since the gregarious phase is obtained more easily and is more typically developed at higher temperatures. This is also in keeping with the above theory, since the general activity of hoppers is greatly affected by temperature conditions.

The results of some experiments suggest that transformation is caused not only by direct environmental influence on the developing individual, but that the conditions of adult life may also have an effect on the characteristics of the progeny. Thus, the progeny of adults of the gregarious phase show certain characters of that phase already in the first instar; Prof. Faure suggests that this is not a case of the inheritance of phase characters, but that the phenomenon may be due to the 'locustine' being handed down to the progeny in the nutritive yolk of the eggs. Indeed, a series of crossing experiments proved that phase characters are not Mendelian characters, and disposed effectively of some earlier suggestions in that direction.

An interesting point is raised by Prof. Faure's experiments on the coloration of solitary hoppers. As a rule, such insects are rather variable in colour but often exhibit a close correlation with the colour of the surroundings. The breeding of hoppers in uniformly painted boxes resulted in many cases in excellent general imitation of the background, even of the white, or black one.

* "The Phases of Locusts in South Africa". *Bull. Entom. Res.*, **23**, pt. 3, 1932, 112 pp., 25 pls., map.

These experiments throw an interesting light on the problem of the so-called sympathetic coloration in insects, and suggest a promising line of research. It was, however, somewhat unexpected that the green colour of environment is not imitated by hoppers, though they often become green on almost any background. Detailed experiments on the production of green coloration showed that it develops when hoppers are kept in a humid atmosphere and supplied with abundant moist food. However, attempts to discover chlorophyll in green hoppers failed, and the problem awaits further investigations.

Another interesting point raised with regard to the brown locust is the ability of its eggs to lie dormant for extremely long periods, up to 37 months after oviposition. A number of other equally interesting and important observations and experiments are recorded in the paper, which contains also a discussion of the bearing which these laboratory results have on the actual locust problem in the field. The knowledge of the phase transformation is already applied in practice in South Africa, and a careful watch for incipient congregations of solitary locusts in the field is kept. All such congregations are destroyed, with the result that the swarming phase has not appeared for several years. Further field ecological work will help in defining more precisely the areas favourable for the production of the swarming phase, and this will facilitate the anti-locust work still more, placing it entirely on the basis of prevention of outbreaks.

Prof. Faure's paper is exceptionally well documented by exact descriptions of experiments, tables of results and extremely well-reproduced coloured plates showing the remarkable range of the variation connected with the phase transformation of the species discussed. The results recorded constitute a great advance in our knowledge of the locust problem, and, moreover, they should go far towards demonstrating to biologists in general the outstanding interest of these insects, on which a number of fundamental problems can be studied better than on any other material.

B. P. UVAROV.

Obituary

PROF. JOHANNES SCHMIDT

THE science of oceanography has lost one of its most outstanding leaders by the death of Prof. Johannes Schmidt, director of the Carlsberg Physiological Laboratory, which occurred at Copenhagen on February 22 at the age of fifty-six years. His loss will leave a host of friends and colleagues all the world over with a sense of personal bereavement and regret, for being himself a great traveller with his home in Copenhagen, the headquarters of the International Council for the Exploration of the Sea, with which he was intimately associated, he was in close and frequent contact with all who were interested in the science of the sea. He was a man of quite exceptional charm, with a genius for friendship, always eager to help the work of others and to appreciate any help which others could give him in the execution of the bold schemes of research which he planned.

The name of Johannes Schmidt will no doubt be chiefly remembered for his solution of the age-old mystery of the life-story of the eel, but this success represented but a small part of his scientific activities and personal achievement. His versatility and breadth of view were striking. Starting his career as a botanist, his first expedition was to Siam in 1899, when he was editor and joint author of a report on "The Flora of Koh Chang". In 1910 he began at the Carlsberg Laboratory a series of investigations on hops (*Humulus lupulus* Linn.), publishing reports on their growth, biochemistry, and occurrence in the wild state in Denmark, and superintending researches on their fertilisation, development and the production of hybrids.

Later, under the inspiring influence of the late Dr. C. C. Joh. Petersen, and helped no doubt by his own enthusiasm for the sea—for first and last and always he was a good sailor-man—Schmidt became attached to the scientific staff which was carrying out Denmark's share of the programme of the International Council for the Exploration of the Sea. The importance of the fisheries at Iceland and the Faroes caused the Danish research vessels to go farther afield than those of the other powers, and the steam trawler *Thor* carried out regular cruises from Copenhagen to the northern waters of the Atlantic.

This was Schmidt's training ground for the extended expeditions in small vessels which he eventually undertook. At first he concentrated on the description of post-larval and early adult stages of fishes, especially of the cod family, and their distribution and migrations in relation to temperature and other physical characteristics of the sea-water. This was necessary pioneer work which has stood the test of time.

In May, 1904, Schmidt was collecting young fishes with large pelagic nets, and captured in the North Atlantic west of the Faroes one specimen of the *Leptocephalus brevirostris*, which Grassi and Calandruccio in 1896 had proved to be the larva of the common fresh-water eel. In the following year (1905) the *Thor* succeeded in capturing, at the end of May, a small number of specimens of *Leptocephalus* over the deep water off the west of Scotland, and still farther south the numbers increased over depths of 1,000–1,500 metres, until, in water of this depth in the central part of the plateau off the mouth of the English Channel, up to 70 per two hours' haul were obtained with nets towed with about 300 metres of wire. A few hauls taken in September, west of the Hebrides, showed that the larvæ were already beginning to meta-

morphose, and would soon completely change into elvers or glass-eels.

To determine where the eels actually spawned it remained to find the earliest larval stages and the eggs. This involved a search extending all over the whole southern and western part of the North Atlantic. Only after years of persistent effort was it possible to reach a full and satisfactory solution of this aspect of the problem. Successful cruises were made in the *Thor* to the Straits of Gibraltar and the Mediterranean (1908–10). Arrangements were made with Danish ship-owners for nets to be towed from steamers crossing the Atlantic by different routes. In 1913 a small sailing schooner, the *Margrethe*, was equipped and cruised in the Atlantic as far as the West Indies, when it was found that the smallest sizes of the larvæ were all taken west of a line drawn from Newfoundland in a south-easterly direction towards Cape Verde. In 1920 a large schooner, the *Dana*, replaced the *Margrethe*, which had been wrecked. After two years it became possible to map out the breeding grounds by a study of the distribution of the earliest larval stages, less than 10 mm. in length, which had all been taken in a comparatively small area, the centre of which lay midway between the Leeward Islands in the West Indies and Bermuda. By these researches Schmidt may be said to have solved the main problem of the life-history of the eel.

With this extension of his cruises into the Atlantic Ocean, the scope of Schmidt's oceanographical work became enormously enlarged, and had developed into an important study of the great oceans. The Danish Government secured a large steam trawler, also named *Dana*, and equipped her as a research vessel. In this ship he undertook a number of voyages in the Atlantic Ocean, the Pacific and the Mediterranean, and finally made the great two years' voyage around the world in 1928–30, an account of which he published in NATURE of March 21 and 28, 1931.

Schmidt's study of the geographical distribution and life-histories of fishes led him, at an early date, into researches on fundamental biological problems concerning the nature of species, of races and of heredity, and his success as a biometrician and as a student of genetics was almost as striking as that which he achieved in oceanography. Biometrical studies on races of fish had formed a feature of his early work on gadoids and eels. Later, in a series of papers published between 1917 and 1922 in the *Comptes-Rendus* of the Carlsberg Laboratory and in the *Journal of Genetics*, the subject was developed on both statistical and experimental lines. Striking results were obtained with the viviparous blenny (*Zoarces*). He was able to show that in some of the Danish fiords the average number of vertebræ in populations of this fish living at the upper ends of the estuaries is significantly lower than that of the populations in the estuary mouths, the latter again being lower than that of populations living outside in the Kattegat. The averages varied progressively from 108·0 to 117·3. The question whether these fluctuations were due to heredity or to environment, or to both these factors, was made the subject of a well-devised series of experiments. A comparison of the average number of vertebræ in 857 mothers, with the corresponding number in 8,570 individuals of their offspring, showed that the values for the offspring continuously increased as the maternal numbers increased from 107 to 119. The conclusion was drawn that such a conformity could not appear if the number of vertebræ in an individual were determined by the environmental conditions existing during development alone. The number of vertebræ must therefore be, in part at any rate, a hereditary character. Experiments were then made by keeping samples of 300 specimens of each of two different populations of *Zoarces* in an enclosed area near the mouth of Ise Fiord in large, perforated wooden boxes, with the result that the difference in the numbers of vertebræ in the two populations did not disappear in the offspring. On the other hand, two samples of the same population, allowed to develop under different environmental conditions, did show a smaller, but significant difference in the number of vertebræ of the offspring.

In continuation of work on race problems, Schmidt carried out many breeding experiments on trout, and on the fresh-water tropical fish *Lebistes reticulatus*, as well as on poultry.

Such a wide and varied field of fruitful effort leads one to ask, what qualities in the man lay at the root of his success? First, I think, a broad, clear outlook on the problems he hoped to solve was followed by a bold but simple and straightforward plan of attack: then, steady, hard, persistent work, carried on year after year with no turning aside, every detail carefully thought out, every operation accurately performed until at last the answer came. He was a fine organiser and knew how to get the best from those who helped him. The brilliant school of young marine biologists in Denmark, who will continue the work that he began, is his true memorial.

E. J. ALLEN.

DR. ALFRED RÉE

IN the death of Dr. Alfred Rée at Withington on February 26, at the age of seventy years, both chemical industry and the profession of science lose an acknowledged leader and one whose wide outlook and sympathy had won universal respect. Dr. Rée was born at Leeds and educated at the Bradford Grammar School and later at the Universities of Geneva and Munich. He was a Doctor of Philosophy of the University of Berne and had travelled widely on the Continent and in the United States, to which circumstance no doubt his interest in international affairs was partly due. He was a warm supporter of Lord Derby when he was forming the English

Speaking Union and many Americans found a genuine welcome at Dr. Rée's house.

Dr. Rée entered business as a dyestuffs manufacturer and was proud of a connexion through Claus Rée and Co. at Clayton with Brooke, Simpson and Spiller, who were successors of Simpson, Maule and Nicholson, and Perkin and Sons, the original manufacturers of mauve. Although he retired from the industry in 1907, he retained many and varied interests in dyestuffs and other branches of chemical industry and was a director for some years of the British Dyestuffs Corporation. He is probably best known for his work for the Manchester Chamber of Commerce; early in his life he was vice-chairman of the chemical section and he played a prominent part in securing reform of the patent laws. Elected a director of the Chamber in 1910, he was made president in 1924–25. He was one of the founders of the Association of British Chemical Manufacturers and served on its Council for several years, being still an honorary member at the time of his death.

With these industrial and commercial interests, Dr. Rée combined a keen interest in education and long served the University of Manchester as treasurer and deputy treasurer. He was for many years chairman of the chemical section of the College of Technology and served on the Manchester Education Committee from 1910 until his death. He was elected a fellow of the Institute of Chemistry in 1918 and served on its Council in 1927–30. He took an active interest in the formation of the British Association of Chemists in 1917 and served as its first chairman. He was one of the oldest members of the Society of Chemical Industry and was a vice-president in 1919–21. He also served as president of the Society of Dyers and Colourists in 1916–17 and his presidential address to that Society is a fine example of his wide outlook and mature judgment.

Few scientific workers have indeed displayed such a fine capacity for public as well as personal service and only Dr. Rée's modesty prevented him from being better known. He was singularly free from ambition and was a most approachable man in spite of his many interests. A quiet but tenacious personality and a rare capacity for impartial judgment won him wide popularity as well as respect, and his indefatigable industry leaves a place among the country's industrial and professional leaders which will be hard to fill.

R. B.

Sir Benjamin Gott

Sir Benjamin Gott, who died on February 26 at the age of sixty-seven years, was one of the group of distinguished educational administrators whose careers virtually began with the passing of the Education Act, 1902. Sir Benjamin held the office of Secretary to the Middlesex Education Committee from 1902 until 1928; he was appointed Organising Inspector of Technical Education in Middlesex in 1898, and, at the date of his retirement, had completed thirty years' service as Education Officer to the Middlesex County Council.

Benjamin Scaife Gott was born at Bingley and became a foundation scholar of Bradford Grammar School. Thence he passed as a scholar to Gonville and Caius College, Cambridge, where he took a first class in Part I and a second class in Part II of the Natural Sciences Tripos. After three years on the staff of Wesley College (now King Edward VII School), Sheffield, he became science master at Cheltenham Grammar School, where he had Sir Robert Blair, afterwards Education Officer to the London County Council, and Mr. E. Salter Davies, Director of Education for Kent, as colleagues. He also acted as Principal of the Cheltenham School of Science.

His duties in Middlesex were at first confined to technical education—the opportunity for the full exercise of his great gifts as an administrator came with the Education Act, 1902, by which the County Council became the higher education authority for the whole of the Administrative County and the elementary education authority for an area containing about one-third of its population. It was Sir Benjamin's ambition to create a system of secondary schools which would make higher education available for all boys and girls of ability, however poor the circumstances of their parents. He had the satisfaction of seeing his ambition realised before he retired. In the interval between 1902 and 1928, the County Council had provided thirty-four new secondary schools and the number of pupils in attendance had increased from 700 to 18,000. In 1898 the Middlesex authority spent £7,000 on education; in the last year of his service, the authority's expenditure was nearly £1,500,000.

Sir Benjamin was, for some time, a member of the Consultative Committee of the Board of Education, the Adult Education Committee, and the Burnham Secondary and Technical Committees. After the War he rendered valuable service as Divisional Director of Industrial Training in connexion with the Ministry of Labour's scheme for the training of disabled ex-Service men. In 1924 he received the honour of knighthood in recognition of his services to education.

Soon after he retired, Sir Benjamin became chairman of the Commission on Educational and Cultural Films. A few weeks before his death he accepted the chairmanship of the Unemployment Committee of the National Council of Social Service, and in order to free himself for the onerous duties of this position, he resigned his membership of the governing bodies of the Northern Polytechnic, University College School and the Maria Grey Training College. This work took him to Bolton the day before he died. Whilst presiding at a conference of voluntary workers, he was overcome by a fainting attack, which was followed by a fatal seizure early the next morning.

MR. W. MCWHIRTER

MR. W. MCWHIRTER, who died at Glasgow on March 6, at the age of eighty-two years, was one of the pioneers of the electrical industry. In 1882 he invented the first instruments for indicating volts and amperes and these he continually developed, introducing magnetic shielding and other devices into his ammeters and voltmeters. His electrical water-level indicators and recorders fulfilled a most useful function.

Apprenticed to his uncle in the bakery and confectionery business, McWhirter spent nearly all his leisure experimenting on magnetism and electricity. He joined the Glasgow and South Western Railway, where he attained the position of divisional inspector. He then joined the Barrow and Furness Railway and was partly responsible for one of the earliest installations of dock lighting by means of arc lamps at Barrow. He was also responsible for the first electric lighting installation at the Glasgow Central Station. In those days the arcs were not well shaded, so that the light was dazzling and cast such dark shadows that one had to walk warily. After lighting the Central Station, McWhirter started business in Glasgow and, later on, opened the Faraday Electrical Engineering Works in Govan, where important improvements were made in the efficiency and commutation of the dynamo.

Mr. McWhirter was well known to all the older generation of electrical engineers and had many friends. He was one of the founders of the Electrical Contractors' Association in Scotland and was chairman of the Scottish centre of the Institution of Electrical Engineers in 1912. In the course of his electrical researches he co-operated with Silvanus Thompson, Ayrton and Perry. One of his pupils was Dr. A. Hay, who was a professor at Coopers Hill and afterwards at the Indian Institute of Science, Bangalore.

WE regret to announce the following deaths :

The Duke of the Abruzzi, Founder's medallist of the Royal Geographical Society in 1901, who was known for his explorations in the Far North, in Africa and in India, on March 18, aged sixty years.

Prof. W. C. Unwin, F.R.S., emeritus professor of engineering in the Central Technical College, City and Guilds of London Institute, president of Section G (Engineering) of the British Association in 1892, of the Institution of Civil Engineers in 1911, and of the Institution of Mechanical Engineers, on March 17, aged ninety-four years.

News and Views

Early Man in East Africa

ON March 18–19 a conference summoned by the Royal Anthropological Institute met at St. John's College, Cambridge, under the presidency of Sir Arthur Smith Woodward, to receive reports on the human skeletal remains discovered by Dr. Leakey's archæological expedition to East Africa in the autumn of last year. On the geological, palæontological, archæological and anatomical evidence, the findings of the respective committees are :—(1) That it is clear that the two fragments said to have been found *in situ* at Kanjera belong to the original deposit and that the fragments cannot have been introduced into the calcareous deposits at a later date ; (2) that the fragment of human lower jaw-bone from Kanam is derived from a deposit of lower Pleistocene age, while the fauna from the Kanjera deposits, in which the cranial fragments were found, cannot be later than the middle Pleistocene ; (3) that the cranial remains from Kanjera show no character inconsistent with reference to the type of *Homo sapiens*, special points noted being the absence of any frontal torus and a thickness of bone not present in any non-pathological modern skull and comparable with that of the Piltdown and Boskop skulls : while the Kanam jaw shows no appearance incompatible with its inclusion in the type of *Homo sapiens* or with the high antiquity assigned to it ; and (4) that the Kanam jaw is associated with a pebble industry, comparable to Oldoway Bed I, which has no precise counterpart in western Europe ; and the Kanjera skull with a Chellean industry corresponding with that of the upper part of Oldoway Bed II, the pebble industry of Bed I being older than the Chellean industry from Bed II, while the latter corresponds typologically to industries from deposits of early Pleistocene age in Europe.

Indian Federation

WITH the publication of the White Paper, discussion of the future government of India enters on its final phase. At this stage it would be vain to expect that any fundamental change will be made in the basic principles upon which the proposed constitution has been framed. For good or for ill, a matter on which time alone will give a ruling, the principles of Western democracy, which themselves in the West are now being strained to breaking point, will be applied to an Eastern community, or rather communities, in which the elements, especially that of Hinduism, as past experience has shown, are further removed in temperament from the spirit of compromise, which is of the essence of democracy, than almost any other community in the world. Hinduism as a social and religious system has shown in the past an almost unlimited power of assimilating elements from outside, but it is itself incapable of adaptation. Even the influence of Mr. Gandhi has not availed to modify the position of the Untouchables, notwithstanding the political gain that thereby would have accrued to Hinduism. However flattering the abortive results of Mr. Gandhi's efforts to the opinion of the scientific observer, he regretfully accepts this as further confirmation of his view that

native institutions alone, and not the restricted individual franchise, could attain in India the desired end of government by consent of the whole people.

Metropolitan-Vickers Representatives in Russia

AT our request, the Metropolitan-Vickers Electrical Co., Ltd., has been good enough to send us the following particulars of its technical representatives, whose recent arrests in Russia have been the subject of a number of questions in Parliament: Mr. Allan Monkhouse, M.I.E.E., A.M.I.Mech.E., who is at present manager in Russia for Metropolitan-Vickers Electrical Export Co., was for several years a senior member of the staff of the Research Department, devoting his interest more particularly during those years to problems on insulation. In addition to his contributions to the scientific press, Mr. Monkhouse wrote "Electrical Insulating Materials" published in 1926. Mr. L. C. Thornton, A.M.I.E.E., left Trafford Park in 1924 to go out to Russia on erection work for Metropolitan-Vickers and has for a number of years been in charge of all erection work in Russia. Mr. J. Cushny, B.Sc.(Eng.), A.M.I.C.E., A.M.I.Mech.E., served his apprenticeship with Metropolitan-Vickers and after serving on the erection staff in Russia for some years, was appointed senior assistant to Mr. Thornton. Messrs. W. L. MacDonald, A. W. Gregory and C. H. de Nordwall, all of whom joined the firm between 1920 and 1922, have been engaged in erection work in Russia for some considerable time. The Metropolitan-Vickers Export Co. has now been supplying plant and machinery to the U.S.S.R. for the last ten years. For the latter part of this time it has had, in addition, an agreement under which technical information and supervision has been supplied by the Company to the U.S.S.R. which has been building the Company's turbines under licence. This agreement is one of the results of the leading position in the field of turbine engineering occupied by the Company, and the agreement has for the last few years been extended to cover the design and manufacture of heavy electrical plant.

Aeronautics and the Royal Air Force

SIR PHILIP SASSOON, M.P., Under Secretary of State for Air, in his air estimates speech in Parliament on March 14 offered a good deal of congratulation to the technical and scientific side of the aeronautical community in Great Britain, in that it has managed to maintain progress and extended activities in spite of a progressive reduction in its expenditures. Special tribute was paid to Sir Richard Glazebrook, who retires at the end of this month from the chairmanship of the Aeronautical Research Committee, where he will be succeeded by Mr. H. T. Tizard, rector of the Imperial College of Science and Technology. Sir Richard has been associated with the scientific side of aeronautics since 1909, and has been chairman of the Aeronautical Research Committee since its formation thirteen years ago. Speaking of the Royal Air Force, Sir Philip said that no new squadrons are being formed, although it is still ten short of the 1923 approved programme, and is closing one flying training school. In spite of reductions it has rendered both direct and indirect assistance to the administration of law and order in the more backward of the Empire territories overseas. The suppression of turbulent tribes, transporting of British troops to stiffen up disaffected native levies, giving flights to political agents and local chiefs in areas in which the inhabitants still held that aircraft were a myth, making a flight over the Himalaya range in 2 hours 20 minutes, which normally needed a 17 day march, are among the direct activities mentioned.

THE humanitarian and less directly productive work carried out by the Royal Air Force during the past year is equally striking. Supply of medical services, flood warnings, surveying, fishery protection, locust fighting, famine relief, mail carrying to isolated communities, have absorbed as much as 40 per cent of the flying time of some of the Middle East squadrons. The making of record flights, such as the recent long distance to the Cape, which now brings the records for speed, height, and distance to British aeronautics, is not without its indirect value to Great Britain's prestige. A new system of subdivision of duties amongst R.A.F. mechanics will make considerable saving in the cost of personnel without affecting the technical efficiency of the aircraft maintenance. This is due to the complete change over to all-metal aircraft. Dealing with civil aviation, Sir Philip referred to the continued expansion of Imperial Airways and promised the Indian extension of the Australian air route during 1933. Air passenger traffic has increased by more than 100 per cent on European, and more than 50 per cent on other Empire, routes.

The Panda at the Zoological Gardens

THE carnivores are really a very remarkable group, ranging in size from the tiger to the weasel, and presenting singular contrasts in the matter of shape. Nor are they all flesh-eaters, some being almost exclusively vegetarians, and one, the kinkajou, has developed a prehensile tongue, like an ant-eater, and a prehensile tail like a spider-monkey. The shape of the body has been moulded by adjustment to their feeding habits. Some have become burrowers, some arboreal, and some aquatic. Their coloration has in like manner been governed by this same factor of food-hunting which of course determines their environment, as witness the polar bear, the tiger, the leopard, and the Cape hunting dog. But there are many other and less familiar types of coloration. Among these is the singular panda (*Aelurus fulgens*), a recent arrival at the Zoological Gardens, Regent's Park. It is a creature which cannot fail to attract the attention of visitors owing to its striking coloration. A native of the south-eastern Himalayas, where it lives among rocks and trees at a height of 7,000–12,000 ft., its habits, and the relation thereto of its coloration, have never been the subject of careful observation. Placed under relatively natural surroundings—which is becoming more and more a distinctive feature of the Gardens—some useful information may be gleaned on this head.

As touching the coloration of the panda in relation to its haunts, we have little to build on at the moment, for while some tell us it is found among the rocks, others tell us that it is arboreal. Probably it affects both environments as circumstances may determine. The racoons, to which tribe it belongs, display a similar versatility. The general hue of the upper part of the body is of a lively chestnut-red, with white markings on the face, while the legs and belly are black. The tail, nearly as long as the body, displays the rings characteristic of the racoon. Since it is largely a vegetarian, with a fondness for fruit, this coloration must be regarded as protective : and it may bear some relation to the positions assumed during sleep when protection of this kind is most needed. But here again we are in need of further observation ; for it is said to sleep coiled up like a cat with the bushy tail over its head, but at other times resting on its haunches with the head tucked under the chest, and between the fore-legs, after the manner said to be common with the racoons. Here, surely, is a matter which can be settled at the Gardens.

Photoelectric Exhibition at the Science Museum

A SPECIAL exhibition devoted to photoelectric cells and their practical applications will be opened at the Science Museum, South Kensington, on March 25, and will remain on view for three months. Photoelectric cells are now being widely applied both in pure science and in industry, and the exhibition is intended to give an illustration of the great variety of these applications. Besides exhibits showing the construction of the three main types of light-sensitive cell, some simple working experiments have been arranged to demonstrate their properties and to illustrate some of the methods of amplifying the small currents yielded by the cells under varying illuminations. The practical applications of photoelectric cells can be roughly classified into those involving only the detection of light and those involving its measurement. The first class is illustrated in the exhibition by a number of working models showing the use of the cells, for example, for counting small packages on a conveyor belt, and in burglar alarms, while, as an illustration of the way in which a comparatively large amount of power can be controlled, there is a door which is automatically opened whenever a certain beam of light is interrupted by the visitor. Applications involving the measurement of light intensity are also illustrated. These include the measurement of daylight or of indoor lighting, the automatic switching of street-lamps, and the measurement of the density of factory smoke, while the ability of photoelectric cells to respond to rapidly fluctuating light is shown by their well-known applications in the reproduction of sound from sound-films, and their use in television.

Early American Bridges

AT a meeting of the Newcomen Society held at the Caxton Hall, Westminster, on March 15, Capt. L. N. Edwards, of the United States Bureau of Roads, read a paper on "The Evolution of Early American Bridges" in which he dealt with the work of the bridge pioneers of America down to the time of the Civil War of 1861–65. All the early settlements, he said, were situated on sheltered bays, tidal inlets or navigable streams and "the water was the first American highway". When roads came to be constructed, it was natural that the necessary bridges should be simply tree trunks felled at the site. Transportation developments were a challenge to those engaged in bridge building and the art of carpentry became of immense importance. In the eighteenth century, pile and trestle bridges came into use and these were followed by arched and trussed structures, some of great span. The Upper Ferry Bridge over the Schuylkill River built by Louis Wernag in 1812 had a wooden arch of 340 ft. span and the McCalls Ferry Bridge over the Susquehana River built by Theodore Burr in 1814 had a central span of 364 ft. Especially important were the trusses patented by Ithiel Town, 1820, Col. S. H. Long, 1830, William Howe, 1840 and the two Pratts, 1844. A wrought-iron chain suspension bridge was built by James Finley in 1801, while in 1842 Col. Charles Ellet built the first wire suspension bridge in America. Cast iron was successfully used for a bridge in 1836. Sixty-seven patents for bridges were issued by the United States Patent Office between 1797 and 1860. The first books on bridge work were by Herman Haupt, 1842, and Squire Whipple, 1847. Capt. Edwards's paper, which was illustrated with many lantern slides, is a notable addition to the history of the subject of American bridges.

Cosmic Radiation

IN his Symons Memorial Lecture delivered before the Royal Meteorological Society on March 15, Mr. P. M. S. Blackett dealt with "Cosmic Radiation". The study of what is now known as cosmic or penetrating radiation began more than thirty years ago with the experimental investigation of the conductivity of the air in closed vessels. By 1932, measurements of the ionisation had been carried out up to heights of 28 km. in the atmosphere and down to depths of 230 m. under water. The ionisation is found to be 100,000 times more intense at the highest point reached compared with that at the greatest depth. More than four hundred papers have been written on the subject and still the nature of the primary radiation is not certain and its origin quite unknown. The ionisation is constant in time to within two per cent at any one place, but is about twelve per cent less intense at the equator than in latitudes of 50° N. and S. From these latitudes to the poles it is nearly constant. It is probable, but not certain, that the primary radiation incident on the earth's atmosphere consists of an isotropic corpuscular radiation with a mean energy of more than 10^{10} volts. The actual ionisation at sea level is due to fast particles, mainly electrons, protons and 'positive electrons'. The tracks of these particles can be photographed by the cloud method and such photographs have shown that very complex phenomena of great variety and interest occur in connexion with the absorption of the primary cosmic rays by matter.

Museums of British Territory in Africa and the Mediterranean

HARD on the heels of the report on Canadian museums by Sir Henry Miers and Mr. S. F. Markham, which was reviewed in NATURE of January 21, p. 84, comes the same authors' "Report on the Museums and Art Galleries of British Africa" together with a "Report on the Museums of Malta, Cyprus and Gibraltar by Alderman Chas. Squire and D. W. Herdman". The report is accompanied by a "Directory" (price 5*s*.) of all these museums, and of those of Mauritius, constituting the third volume of the "Directory of Museums" being published by the Museums Association. To visit the forty museums of Africa was a strenuous enterprise even with all the resources of modern transport. Those museums cover a wide range in quality and administration as well as in distribution, from the fine South African Museum in Cape Town to the poor apology for a scientific museum, which, as the authors say more than once, is unworthy of that rich city Johannesburg. Poverty coupled with handsome buildings are the characteristics of the South African museums—a combination not unknown in other lands. Their chief needs are said to be "greater financial security, some forms of active co-operation between all museums, and the development of educational work".

THE museums of the East African and West African territories are barely out of the shell, so that the reporters can do little more than tender good advice. The Coryndon Museum at Nairobi and the Zanzibar Museum are the only institutions worthy to be called public museums. Over areas to be measured in millions of miles, museums are needed to fulfil what is still the first purpose of a museum—the preservation of objects that would otherwise be lost, and nowhere is civilisation more destructive than in Africa. The Mediterranean museums present different problems, but here too it is this primary function that comes first in the report, as shown by its insistence on permanent curators, a higher standard of curatorship, protection against fire, and cases that will keep out dust and insects. The value of these reports to the museums concerned, and the usefulness of the directories to those elsewhere, can scarcely be exaggerated. That on Canada is already fruitful of results; though its criticism was severe, its expression was tactful and it has aroused no resentment but rather a determination to profit by it. Great credit and warm thanks are due to the Museums Association which does the work and to the Carnegie Corporation which provides the funds.

Measurement of Chimney Smoke

MAJOR C. E. PRINCE gave an interesting lecture to the Junior Institution of Engineers on February 24 on the practical applications of light-sensitive apparatus. The effects produced by a beam of light when projected on vapours, the particles of which, like drops of water, are possessed of reflective and refractive powers, have to be studied. The most useful effect for observation is the deflection or scattering of the beam. In the case of smoke, the interruption of the light by the particles of carbon gives the easiest and best method of measurement. Major Prince showed apparatus in which a beam projected through smoke and then on to a light-sensitive element gave a continuous quantitative record on a moving chart of the diminution of light due to the smoke. One difficulty was to interpret the readings in terms of a definite unit as the cut-off varies with the depth of the column penetrated by the light. The problem is of importance as it gives a method by using indicating or recording instruments for proving or refuting a contention that excessive smoke was being or had been allowed to issue from industrial chimneys. The present method of visual observation and comparison with a Ringelmann screen at the chimney top takes little or no account of the size of the chimney and consequently of the volume apart from the density of the issuing smoke. It neglects also the direction of the wind and its effect upon the apparent density of the smoke. It is necessary to define more accurately the density of smoke at a given distance. By using a selenium or a photoelectric cell, this is possible. It remains for those who have the managing of smoke-producing units and those who apply the regulations governing smoke nuisance to agree on a standard method.

National Institute of Agricultural Botany

ONE of the ways in which the Government in Great Britain is aiding agriculture is through grants made to the National Institute of Agricultural Botany. This Institute is doing very important work for the farming community by testing seeds and by encouraging the use of better varieties of plants. The thirteenth annual report, which has just been published, states that the record number of 30,689 samples of seeds was tested in the year ended July 31, 1932, at the Official Seed-testing Station. Trials with oats showed that one variety, Golden Rain II, gave the best results, although it is not widely grown; and that in Wales the variety popularly believed to be the best (Record) was significantly inferior to the three other varieties tested. The outstanding problem in the home beet-sugar industry is to improve the yields of beet and of sugar per acre; whereas the average for Europe is about 1½ tons of sugar per acre, in Great Britain it is only slightly more than 1 ton. The Institute has been attacking this important problem and has demonstrated how much these yields depend upon the variety grown. Trials extending over three years have shown differences of nearly 20 per cent between varieties in use by farmers, and Kleinwanzleben *E* has in general been found to be by far the best; at one centre it gave no less than 3 tons of sugar per acre. As a result of this work, it is now possible to recommend twelve different strains for use in the British Isles. Other activities of the Institute include the provision of pure stocks of cereal seed, the improvement of varieties of potato in respect of yield, and, especially, of immunity from disease, and the prevention of the use of more than one name for the same variety.

Minimum Climatic Temperature

A RECENT note by C. F. Talman of the United States Weather Bureau, one of the "Why the Weather?" series issued by Science Service, Washington, D.C., describes an observation of some interest for those who attach importance to climatic extremes. The note states that when Archdeacon Stuck climbed Mount McKinley, Alaska, in 1913, he placed a minimum thermometer in a small wooden case and fastened it securely in a cleft of rock at a height of 15,000 feet above sea level. When the thermometer was recovered last May, it was found that the index was down in the bulb, and indicated a minimum at least as low as −100° F. Mr. Talman finds it difficult to say how much confidence can be placed in the observation; one possibility suggested is that vibration due to strong wind caused the index to fall below what should have been its lowest position. According to the 1930 edition of the "Meteorological Glossary" of the Meteorological Office, Air Ministry, the lowest temperature recorded at the earth's surface is −93·6° F. at Verkhoïansk, Siberia, on January 3, 1885. There is now at least one colder place in Siberia than Verkhoïansk equipped as a climatological station; such a place would probably have yielded a lower reading than −93·6° had it been in operation in 1885. In the free air, much lower readings have been recorded at greater heights in low latitudes, where the normal fall of temperature with height is maintained to such high levels that in spite of the relative warmth near the ground a lower temperature is recorded than at any height in temperate or high latitudes. The "Meteorological Glossary", for example, refers to a reading of −131·6° F. obtained at a height of about 54,000 feet above Batavia, Java.

Archæology and Tradition

THE Sir John Rhys memorial lectures of the British Academy, inaugurated in 1925 and delivered annually since that date, have now secured, as a series, a place in Celtic studies worthy of the great scholar they commemorate. The lectures have been apposite in subject and the lecturers have never failed to stimulate interest in their special field. The latest lecture to be published (London: Oxford University Press. 1*s*. 6*d*. net), by Prof. H. Fleure on "Archæology and Folk-Tradition", deals with a matter of interest to both archæologist and folklorist, but perhaps at the present stage in archæological studies, more particularly to the former. The illustration, or perhaps illumination, of conclusions derived from archæological data by reference to tradition and legend may become an alluring, but somewhat hazardous, exercise in ingenuity. Prof. Fleure's suggested relation of "The Twilight of the Gods" to a period of climatic deterioration and racial unrest in bronze age Europe is suggestive, but at the same time by its very restraint inculcates caution in those who have not his wide knowledge of the archæological aspects of ancillary sciences such as meteorology, botany, and geography, which is essential for a synthesis such as he essays. Turning more specifically to Britain and the relation of British and Irish archæology to Celtic tradition, his interpretation, for example, of Irish ethnic tradition shows by precept and example how at each stage the argument must adhere rigidly to ascertained fact. Yet notwithstanding his caution, Prof. Fleure feels able to place some reliance on the traditional Spanish connexion of early Irish peoples and incidentally to offer an enlightening suggestion as to the possible origin of the obscure Tuatha de Danann.

Submarine Telephone Cables at Carrier Frequencies

IN ordinary telephony the sound waves falling on the microphone vary the pressure on the carbon granules through which a current is flowing. The resistance of the circuit thus varies, and so the current varies with the sound wave and in the receiver produces sound waves exactly similar to the original waves. In radio-telephony, in place of the current in the connecting wires, we have a high-frequency current emitted from the transmitter. This is varied (modulated) by the sound waves. These modulated waves falling on a suitable receiver reproduce waves similar to the original sound waves. Better results are obtained by using conducting wires, and in particular submarine cables. The cost of the cable in this case makes it necessary that it should carry pairs of wires providing several channels of communication. The disadvantage of this type of cable is the great difficulty of laying and maintaining it in deep water. For deep sea work a single core cable is used provided with a copper sheath under the armouring to carry the return current. In 1920 the serious single-channel limitation of this type of cable was overcome by the use of carrier wave high frequencies. This enabled telephone cables to be laid and operated between Key West (Florida) and Havana, a distance of 103 nautical miles. In a paper read to the Institution of Electrical Engineers on February 23, Dr. E. W. Smith discusses the electrical requirements for this type of transmission. He also summarises the most recent advances in materials and methods of construction and indicates probable future developments.

A Modern Granary

WHAT is described as the largest granary in South America, and in equipment, probably the most complete in the world, is described in *Engineering* for February 10 and 24 and March 10. The granary has recently been erected by the Buenos Aires Great Southern Railway at the port of Bahia Blanca, Argentina, at a cost of about £1,000,000. The plant consists of an unloading station for the discharge of grain from the railway wagons, a ferroconcrete granary of 80,000 tons capacity, a loading jetty and shipping galleries. For the transport of the grain there are no fewer than 120 conveyors having more than twelve miles of conveyor and elevator belting. The whole plant is driven electrically, current being supplied from a sub-station to some 240 electric motors of an aggregate horse power of about 10,000. Some idea of the capacity of the plant can be obtained from the statement that, while grain can be unloaded continuously at the rate of 1,000 tons an hour, on the outgoing side six ocean-going ships can each be

loaded simultaneously at the same rate. Each year Great Britain imports about 1,000,000 tons of wheat from the Argentine, and it is a matter for satisfaction that the main contract for the buildings, plant and equipment of this notable granary amounting to about £800,000 has been carried out by Messrs. Henry Simon Ltd., of Manchester, at which place the machinery and equipment were assembled before shipment to South America.

Aluminium in Food-Stuffs

ATTENTION has been directed of late to the effects of, and possibility of poisoning from, aluminium derived from food-containers and cooking utensils. In view of the importance of the subject, the Mellon Institute of Industrial Research, Pittsburg, Pennsylvania, has instituted a critical search of the scientific literature relating to the chemistry and pharmacology of aluminium, and has now published "A Select Annotated Bibliography on the Hygienic Aspects of Aluminium and Aluminium Utensils", giving the scope, with critical notes, of the papers consulted (Bibliographic Series, Bull. No. 3). Dr. Beal, assistant director of Mellon Institute, contributes an introduction in which he concludes that aluminium is not a poisonous metal and does not give rise to any disease, that aluminium utensils are very resistant to corrosion by food-stuffs cooked therein, and that aluminium does not accelerate the destruction of vitamin or other food accessory substances during cooking.

Announcements

THE Right Hon. Lord Stonehaven has accepted nomination as president of the Institution of Naval Architects in succession to Admiral of the Fleet, Lord Wester Wemyss. The election of the new president will take place at the opening meeting to be held at the Royal Society of Arts on April 5.

DR. J. T. DUNN has been elected president of the Society of Chemical Industry for 1933–34, in succession to Dr. R. H. Pickard. Dr. Dunn was appointed headmaster of Gateshead School in 1886, and then head of the Plymouth Technical School in 1894. Later he became the first principal of the Northern Polytechnic, Holloway. He is now the public analyst of Northumberland, and in 1930–32 was president of the Society of Public Analysts.

THE gold medal of the Institution of Mining and Metallurgy has been awarded to Sir John Cadman, in recognition of his work in the advancement of technical education and the development of the mineral industries; and of his distinguished public services. The following awards have also been made: Consolidated Gold Fields of South Africa, Ltd., gold medal to Mr. C. A. Banks for a paper on "Air-Transportation of Gold Dredges in New Guinea"; Consolidated Gold Fields of South Africa, Ltd., premium of forty guineas conjointly to Mr. J. L. Francis and Mr. J. C. Allan for their paper on "Driving a Mines Drainage Tunnel in North Wales"; William Frecheville student's prize of ten guineas to Mr. G. J. Williams for a paper on "The Genesis of the Perrunal—La Zarza Pyritic Orebody, Spain".

AT the annual general meeting of the Geological Society of London held on February 17, the following officers were elected for the ensuing year: *President*, Sir Thomas Holland; *Vice-Presidents*, Prof. E. J. Garwood, Mr. J. F. N. Green, Mr. W. Campbell Smith, and Prof. W. W. Watts; *Secretaries*, Prof. W. T. Gordon and Prof. P. G. H. Boswell; *Foreign Secretary*, Sir Arthur Smith Woodward; *Treasurer*, Mr. F. N. Ashcroft.

UNDER the terms of the Thomas Gray Memorial Trust, the Royal Society of Arts is offering a prize of £100 for an improvement in connexion with the science or practice of navigation, invented in 1932 or 1933; also a prize of £100 for an essay on fire at sea. Further particulars can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

PROF. B. W. HOLMAN, honorary general secretary of the Association of Scientific Workers, 70 Victoria Street, London, S.W.1, informs us that the Association is engaged in compiling a handbook of "Extra-University Research in Pure and Applied Science", in which it is proposed to give data concerning commercial, endowed, and private laboratories not included in the "Universities Yearbook". It is not intended to include laboratories and other institutions devoted solely to testing materials and products, collecting data and other work not of a developmental and original character. Firms and others who are engaged in research are invited to communicate with the Association.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in mathematics and science as applied to the building industry at the Northern Polytechnic, Holloway, London, N.7—The Clerk (March 31). An assistant to the City Analyst under the Leeds Corporation—The Medical Officer of Health, 12, Market Buildings, Vicar Lane, Leeds, 1 (April 3). A woman lecturer in mathematics and elementary science at the Municipal Training College, Cottingham Road, Hull—The Principal (April 5). A demonstrator in physiology and dietetics at King's College of Household and Social Science (University of London), Campden Hill Road, W.8—The Secretary (April 13). An engineer-manager for the States of Guernsey Electricity Department—The President, Appointments Board, Royal Court, Guernsey (April 15). A senior assistant in the Nautical Almanac Office—The Secretary, Civil Service Commission, Burlington Gardens, W.1 (April 20). A professor of pathology at the University of Bristol—The Secretary and Registrar (April 20). A lecturer in civil engineering at the University of Leeds—The Registrar (April 22). A professor of mental and moral philosophy at the University of Otago, Dunedin, New Zealand—The High Commissioner for New Zealand, 415, Strand, W.C.2.

ERRATUM.—In NATURE of March 18, p. 385, col. 1, line 26, for "*Odonatra zibethica*" read "*Ondatra zibethica*".

Letters to the Editor

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

Nuclear Energy Levels

IT is a plausible hypothesis that the forces acting on a particle inside the nucleus are comparatively weak in the internal region and increase rapidly to the boundary of the nucleus, the potential distribution being represented by a hole with more or less flat bottom and rather steep walls[1]. If we approximate this model by a rectangular hole with infinitely high walls, the energy levels of a moving particle will be determined by the roots of Bessel functions and can be easily calculated. For the real model, however, this theoretical level system will be deformed owing to the fact that the walls are neither quite steep nor infinitely high, producing compression of the upper part of the level system.

The best nucleus for testing this hypothesis is that of radium C′, for which a lot of experimental evidence is available. For this nucleus we have the measurements by Rutherford[2] of long range α-particles (nine groups) giving us approximate positions of nuclear levels. The investigations of Ellis[3] give for a number of γ-lines (nine lines) their absolute intensities and, what is most important, the values of internal conversion coefficients enabling us, as has been shown by Taylor and Mott[4], to tell the dipole transitions from quadrupole transitions.

These data are sufficient to construct the level system of the radium C′ nucleus, the main part of which is represented in Fig. 1, together with the theoretical one.

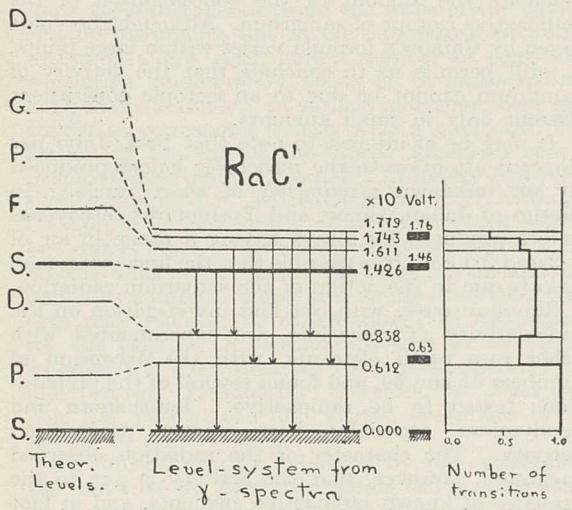

FIG. 1.

We see immediately that not every level corresponds to a long range α-group; this is, however, to be expected, as the probability of α-disintegration from a level with large j is comparatively small, due to the additional barrier of centrifugal forces (for equal energies the probability for an α-particle escaping from P-, D-, F-, G-levels will be respectively 1·3, 4, 16 and 105 times less than for the S-level). The observed transitions are given in the accompanying table.

CONSTRUCTED		OBSERVED		CONSTRUCTED		OBSERVED.	
$h\nu \times 10^{-6}$ volt	Δj	$h\nu \times 10^{-6}$ volt	Δj	$h\nu \times 10^{-6}$ volt	Δj	$h\nu \times 10^{-6}$ volt	Δj
0·588	2	0·589	..	1·131	0	1·130	0 ; 2
0·612	1	0·612	1	1·167	1	1·168	..
0·773	1	0·773	1	1·426	0→0	1·426	0→0
0·838	2	0·839	..	1·743	1	1·744	..
0·941	0	0·941	0 ; 2	1·779	2	1·778	0 ; 2
0·999	2	1·000	..				

From twenty-one mathematically possible transitions, eleven are actually found and, as can be seen from the table, have appropriate energies and obey the exclusion principle. From the remaining ten lines, two are not to be expected corresponding to $F \rightarrow S$-transitions, four fall in a spectral region not yet investigated and four are not observed, possibly due to comparatively small intensity. It is also of interest to construct an excitation diagram, building up the sums of the intensities for all lines crossing a given level interval. From this diagram we see that there must be a γ-line $0{\cdot}226 \times 10^6$ volt with absolute intensity about 0·2 which at present is not known.

The similarity of theoretical and real level systems proves the correctness of our picture of the potential inside the nucleus, and the deviations between these systems must permit us to calculate the real potential distribution.

G. GAMOW.

Research Institute of Physics,
University,
Leningrad.
Jan. 30.

[1] Gamow, *Proc. Roy. Soc.*, A, **123**, 632; 1930.
[2] Rutherford, *Proc. Roy. Soc.*, A, **131**, 684; 1931.
[3] Ellis, *Proc. Roy. Soc.*, A, **129**, 180; 1930.
[4] Taylor and Mott, *Proc. Roy. Soc.*, A, **138**, 665; 1932.

Atomic Moments of Ferromagnetics

No satisfactory explanation has hitherto been given of the values found for the magnetic moment per atom in ferromagnetics, as deduced from the saturation magnetisation at low temperatures. These values for the three ferromagnetic elements are as follows:

Fe	Co	Ni	
11·0	*c* 8·6	3·0	Weiss magnetons
2·22	*c* 1·7	0·606	Bohr units

Now it is known from the experiments on the gyromagnetic effect that the g value for the carriers, at least at room temperature, is close to 2, while the form of the magnetisation temperature curves approximates closely to that for carriers for which $j = \frac{1}{2}$; the magnetisation may thus be attributed almost entirely to electron spin, any direct orbital moment effect, except possibly at higher temperatures, being comparatively small. A magnetic moment corresponding to an integral number of Bohr units per atom might therefore be expected.

To account for the non-integral values, two suggestions have been made (apart from those in which the reality of the Weiss magneton is accepted). In one of these (Stoner, 1926) the ferromagnetic is regarded as an equilibrium distribution of neutral atoms, ions and free electrons, the free electrons having no resultant moment, and the atoms and

ions making contributions corresponding to their spin moments. In another (Wolf, 1931) a mixture of atoms in different possible spectroscopic states is postulated (for example, for nickel, ^3F and ^1D states, corresponding to moments of 2 and 0). To both of these suggestions there are a number of fairly obvious objections.

The essential fact which has to be explained is that the moment per atom in the aggregate is less than, though a considerable fraction of, the spin moment of the free atom in its normal state (2, 3 and 4 for nickel, cobalt and iron). It is suggested here that a satisfactory interpretation may be obtained by fusing the justifiable assumption of a positive interaction integral, the essential basis of the Heisenberg theory of ferromagnetism, with the treatment of the metallic state as developed by Bloch, Peierls, Brillouin, Wilson and others. The tendency to parallel setting of electron spins will be opposed by the tendency of the electrons to occupy the lowest 'cells' in the energy band or bands associated with the 'unpaired' electrons in the unperturbed atoms. Thus in nickel (d^8s^2 ^3F) four cells are contributed to the aggregate by each atom, and two electrons.

The cells may be regarded as being in pairs corresponding to the two spin orientations for each momentum range. With normal interaction, the pairs of cells, from the lowest upwards, will be occupied by electrons with oppositely directed spin; but when the interaction integral is positive, there will be a number of uncompensated parallel spins. The equilibrium state will be that in which increase in the number of unpaired parallel spins, at the expense of the paired, corresponds to an increase in kinetic energy greater than the decrease in energy due to the interaction. The equilibrium is similar to that considered in the Pauli treatment of the constant paramagnetism of an electron gas, except that the tendency to parallel alignment is due to the interaction instead of to the external field. Numerically, the requirements are that the width of the energy band should be considerably less than kT_0 and greater than $k\theta$, where T_0 is the temperature corresponding to the zero point energy of the idealised free electron gas, of the order 10^4, and θ is the Curie temperature of the order 10^3. This width is compatible with the general theoretical indications.

The above treatment appears to lead also to a straightforward interpretation, in simpler cases, of the changes of atomic moment due to substitution of foreign elements in ferromagnetics, shown by Sadron's results for an extensive series of alloys, and to shed light on some of the obscure energetic characteristics of ferromagnetics. It is hoped that a more detailed account will be published shortly.

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Feb. 16.

Range of Radiation from Samarium

In NATURE of December 3 we announced the discovery of radiation of α-ray type emitted by samarium. Recently we have determined the range of this radiation. The apparatus used, to which Prof. H. Geiger had kindly directed our attention, consisted of a perforated Geiger-Müller tube, surrounded by a cylindrical brass tube, the inside of which was coated with samarium oxide. The whole system could be evacuated, and the pressure could be varied until no more α-particles reached the counter. From the air pressure and the distance between the samarium oxide layer and the counter, the range of the particles could be determined. The value for the range of the samarium radiation in air at atmospheric pressure was found to be $1 \cdot 1_3$ cm. at 15° C. The reliability of the method was checked by determining the range of the α-rays of radium F and a value of 3·90 cm. was found. Making use of the known relation between range and velocity of α-particles, we can conclude that particles having the velocity of $1 \cdot 05 \times 10^9$ cm. sec.$^{-1}$ are emitted by samarium. That samarium emits α-particles and not H-particles could be proved by comparing the magnitude of the electrometric deflections obtained when counting the number of α-particles emitted by samarium, and also the magnitude of the deflections which polonium radiation produced, when the range of the particles was cut down to $1 \cdot 1_3$ cms.

The calculation of the period of samarium from the range of radiation by means of the Geiger-Nuttall relation when making use of Gamow's formula requires the knowledge of the size of the samarium nucleus. When we assume the radius of the latter to be 6×10^{-13} cm., we obtain 10^{15} years, while to a radius of 8×10^{-13} cm., a half period of 10^{12} corresponds. The period of samarium may be determined by counting the number of α-particles emitted by a known amount of this element. We find, that 1 gm. of samarium emits 75 α-particles a second. From this it follows that the half period of samarium is $1 \cdot 2 \times 10^{12}$ years. If the activity is not due to the main isotope of samarium, but to a minor isotopic constituent, then the above figure has to be divided by the value of the concentration of the radioactive isotope. By comparing the period calculated by means of the Geiger-Nuttall relation, when making use of Gamow's formula, and the period obtained by counting the number of α-particles emitted, we can calculate the amount of the concentration of the radioactive isotope of samarium. Although the value given by Gamow's formula varies within large limits, it still permits us to conclude that the activity of samarium cannot be due to an isotopic constituent present only in small amounts.

It may be of interest to note that Prof. Joly[1] has directed attention to the pleochroic haloes produced by an unknown α-radiation of short range. In biotite of Japan, Iimori and Yoshimura[2] discovered haloes produced by α-rays having a range in air of 1·2 and 2·1 cm. It is possible that the first-mentioned halo is due to the action of the samarium radiation.

Simultaneously with our first investigation on the radioactivity of samarium, we experimented with other rare earth elements, with the exception of numbers 61 and 69, and found several of the preparations tested to be radioactive. Lanthanum and neodymium especially have shown pronounced activity. The character of the radiation observed suggested, however, that the activity is due to the presence of known radioactive elements, and in fact we were successful, by using the usual reactions of radiochemistry, in removing the activity observed. The only member of the radioactive disintegration series which cannot be removed by simple methods is the rare earth element actinium. The disintegration of actinium is, however, a 'rayless' one.

In a recent note, Libby and Latimer[3] announced the discovery of the radioactivity of lanthanum and neodymium, and stated that the activity of the

latter element is nearly as intense as that of samarium; while that of lanthanum was found by them to be about three times more active than samarium. We have, therefore, to conclude that this activity is not a property of the elements themselves, but belongs to the radioactive impurities present, a possibility mentioned by the above writers.

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Feb. 13.

[1] *J. Chem. Soc.*, **125**, 897; 1922.
[2] *Sci. Pap. Inst. Phys. and Chem. Res.*, Tokyo, **66**, 11; 1926.
[3] *J. Amer. Chem. Soc.*, **55**, 433; 1933.

A New British Record of *Orthopodomyia pulchripalpis*, Rondani (Diptera, Culicidæ)

ON March 8 we collected a number of mosquito larvæ from a rain-filled cavity in a local elm tree, and found them to be the second, third and fourth instars of the arboreal mosquito *Orthopodomyia pulchripalpis*, Rondani. So far as we are aware, this species has never been collected in the adult stage; its eggs have never been obtained; and records of its larvæ are few and far between.

The British localities in which tree-holes containing larvæ of *Orthopodomyia pulchripalpis* have so far been recorded are as follows:—Epping Forest, Essex (A. Macdonald, 1919, and H. Main, 1919): Kensington Gardens and Buckingham Palace Gardens, London (F. W. Edwards, 1926): Burnham Beeches, Bucks (P. A. Buxton, 1928): Cambridge (D. Keilin, 1929, and T. T. Macan, 1931): Ripley, Surrey (M. E. MacGregor, 1930): and Hardwick, Cambs (T. T. Macan, 1932).

In the present instance, the cavity containing the larvæ is a natural rot-hole; its entrance, which faces north-east, is about three feet from the ground. On the day following our discovery of the larvæ we scraped some vegetable matter from the walls of the cavity, and on examining this in our laboratory we found within it a few eggs, and a number of egg-shells, which are undoubtedly those of *O. pulchripalpis*. Both in structure and in surface markings these eggs appear to correspond exactly with a published illustration of the egg of the North American species *Orthopodomyia signifer*, Coquillet (formerly *Bancroftia signifer*, Coquillet)[1]. According to Dr. F. W. Edwards, *O. signifer* is structurally allied to *O. pulchripalpis*, but differs from it by having scattered white scales on the wings[3]. It seems probable to us that not only the adults of these two species but also their eggs may likewise be differentiated by coloration; for the eggs of *O. signifer* are said to be black[2], whereas the eggs that we have now obtained are light brown. Presumably, therefore, our local tree-hole has yielded the first known specimens of the egg of *O. pulchripalpis*.

An unusual feature exhibited by the egg-shells is the fact that the plane containing the opening made by the emerging larva is inclined at an angle of about 45° to the axis of the egg, instead of being at right angles thereto as in the genera *Aedes*, *Theobaldia* and *Culex*.

In published descriptions of the larva of *O. pulchripalpis*, attention has been directed to the remarkable enlargement of the thoracic portions of the two main tracheæ. We find that each main trachea has, in addition, two quite conspicuous dilatations lying within the fifth to seventh abdominal segments. This peculiarity (which appears to have been hitherto overlooked) is especially noticeable in the second and third instars. We venture to suggest that these tracheal dilatations may have some relation to the air-sacs which lie within the seventh abdominal segment of the larva in the case of *Chaoborus* and *Mochlonyx*.

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March 13.

[1] Howard, Dyar and Knab, "The Mosquitoes of North and Central America", vol. 2, plate 145.
[2] *Ibid*, vol. 4, p. 890.
[3] Edwards, F. W., "A Revision of the Mosquitoes of the Palæarctic Region", *Bull. Ent. Res.*, vol. 12, p. 290.

Sporulation of *Helminthosporium avenæ* in Artificial Culture

IN 1923 an investigation was commenced on the fungus *Helminthosporium avenæ*. Recently an interesting observation was made and a note is now made of it.

Diversity of opinion exists as to the ease with which the various species of *Helminthosporium* produce spores in artificial culture. In view of conflicting statements, Turner and Millard[1] made a detailed study of a *Helminthosporium avenæ* culture. A wide range of media was used to embrace varying carbohydrate and nutrient contents, hydrogen ion concentration and sterilisation methods. No sporulation occurred on any of the cultures excepting on sterilised oat leaves, and then only sparsely.

I was myself unable to induce any marked sporulation until recently, when I inoculated two Petri dishes containing potato agar with mycelium from a non-sporing culture of *Helminthosporium avenæ*. Three days after the inoculation was made, the upper cover of the Petri dish was removed and a disc made from Sanalux glass was substituted. One half of the disc in both cases was painted over with Indian ink. Both cultures were then irradiated for ten minutes at a distance of one foot from a Hanovia quartz mercury-vapour home model alpine sun lamp, alternating current equipment, 200 volts. A subsequent irradiation was made for ten minutes, six days later. Seven days after this, the cultures were examined microscopically and it was noted that the mycelia on the irradiated halves were strongly pigmented and that very abundant sporulation had taken place: pigmentation was very slight on the non-irradiated halves and no sporulation had taken place.

Other experiments of a somewhat similar nature have shown that sporulation of *Helminthosporium avenæ* can be induced by irradiating with the light from a quartz mercury-vapour sun lamp; and also that sporulation will take place if non-sporing cultures are submitted, out of doors, to either strong diffuse light or sunlight. These experiments will be described elsewhere.

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Feb. 20.

[1] Turner, D. M. and W. A. Millard, *Ann. App. Biol.*, **18**, No. 4, 543–546.

Origin of Spontaneous Mutations

SPONTANEOUS mutations are generally supposed to be induced by some unknown external agent. However, it may be expected that mutation is influenced also by certain intracellular processes which develop automatically and may be created or accelerated by artificial means (for example, by X-rays).

Seeking to secure some additional evidence, I decided to test the effect of *prolonged dormancy of seeds* upon the rate of chromosomal mutations. Resting seeds were selected as material for the following two principal reasons: first, because the alleged external slight influences are able to accumulate only in material that is not exchanged or propagated during the whole period of experiment; secondly, because the anabiotic state is distinguished by the preponderance of katabolic processes, which may be supposed to disturb in the course of time the energy balance within the cell; and it seemed to be not improbable that such a disturbance would ultimately increase the rate of mutation.

In the early spring of the past year, two mixed lots of aged seeds of *Crepis tectorum* L. were planted in the usual manner. One of them, culture No. 32.593, was collected in 1925 from plants each of which was individually examined cytologically during that summer. At that time the rate of spontaneous dislocations was about 0·1 per cent or *one per thousand* (M. Navashin, 1926). The second lot, culture No. 32.594, came from plants grown in 1926 largely from the same 1925 seed. Both lots germinated poorly and mostly produced abnormal and weak seedlings. Among them were recorded many albinos; the majority displayed various developmental abnormalities and died before forming the growing cone or soon after. The whole population strikingly resembled one obtained from soaked seed which had been treated by a heavy dosage of X-rays (for *C. tectorum* such an effect is obtained from dosages about 3000 r).

Some thirty plants survived until they reached the age when they could be transplanted into pots. Some of them afterwards died, so that full maturity was reached by only twenty-seven of them, twenty-two of culture No. 32.593 and only five of culture No. 32.594. When the plants were about two months old, root tip material was taken from them individually for cytological investigation. The plants were kept under observation and displayed various abnormalities during their further development; many of them showed great reduction of fertility. Seeds were collected from them individually for further investigation.

The study of the root tips performed in collaboration with Miss Gerassimova of this Institute disclosed an astounding fact: *the great majority of the plants* (more than eighty per cent) *were chromosomal mutants of one sort or another*. None of the mutant plants was uniformly altered in all its cells, but all were *chromosomal chimæras* composed of at least two kinds of tissues, one with the normal chromosome complement and the other or others containing reorganised chromosomes. The great majority of mutant roots were uniformly altered in all their cells but in two instances chimærical roots occurred. The alterations observed were translocations involving one, two or more chromosomes. One case could be interpreted as inversion.

The data obtained were unusual to such a degree that it might be supposed that some special conditions were responsible for the situation. In order to check this, several lots of aged seeds of *Crepis tectorum* (of different origin) were germinated. Some of them produced rootlets that contained no division figures, but one lot of 1927 gave good material. In spite of the high percentage of germination (it was as high as 39 per cent) no normal seedlings whatsoever were produced. In all rootlets from this seed the chromosomes were found to be in a state of profound disintegration, and disregarding rare normal cells, each individual cell displayed a chromosome complement *sui generis*. Grotesque fragmentations, translocations, chains of chromosomes, etc., were observed. Resting cells contained degenerating globules of chromatin scattered throughout the cytoplasm, and adventitious small nuclei were not infrequent. Of special interest was the occurrence of ring-chromosomes, a phenomenon which has been found only once in a single seedling raised from fresh seed among many thousand individuals studied (M.N., 1931). Again the picture strikingly resembled that observed in seedlings fixed very soon after X-raying.

Fuller discussion of the subject, together with additional evidence which is now being accumulated, will appear in the near future in a joint paper with Miss Gerassimova. The purpose of this preliminary note is to report the above facts, which undoubtedly deserve earnest consideration. If the phenomena reported above should prove to be of wide occurrence, the process of mutation, it is evident, should be considered from a new point of view, the theoretical and practical bearings of which are obvious.

An attempt to evaluate them at this stage of our knowledge may seem to be premature. One is safe, however, in concluding that, first, selective mortality had absolutely nothing to do with the enormous increase in the rate of mutation discovered (cf. De Vries, 1901; Heribert Nilsson, 1931); for, granting that as much as one per cent of spontaneous mutants existed in the fresh seed (which is ten times the actual value) the percentage of germination should obviously have been only one per cent to account for 100 per cent mutants, while in reality as much as 39 per cent of seed germinated. Secondly, the observed increase in the mutation rate cannot be attributed to accumulation of the direct effects of some external agency like radiation and the like; for the ratio of mutants was shown not to be proportional to the length of the period of 'rest', but, on the contrary, must have grown with an enormous and progressive velocity until after five years it was a thousand times as great as after one year. One is forced thereby to the conclusion that the main agency that caused spontaneous chromosomal mutations should be sought not outside but rather *inside* the cell. The same would probably also hold true for factor mutations.

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Jan. 20.

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Nilsson, N. Heribert. "Sind die induzierten Mutanten nur selektive Erscheinungen?" *Hereditas*, **15**, 320-328; 1931.

Strepsinema Stage in Reduction

L. W. SHARP in his "Introduction to Cytology" (1st ed. 1921 and 2nd ed. 1926) and C. D. Darlington in "Recent Advances in Cytology" (1932) wrongly attribute the origination of the term 'strepsitene' to me. As a matter of fact, I never used this term, but suggested in 1899 the now generally used 'strepsinema'. I coined this word to describe the origin of the bivalent chromosomes of the heterotypic division first recorded by me in 1895 ("The Chromosomes of *Lilium longiflorum*", *Proc. R.I.A.*, 1895). The term 'strepsinema' is now often assigned to Grégoire owing, I believe, to an accidentally ambiguous expression of that writer, namely, "C'est le stade des noyaux *diplotènes* (Winiwarter, 00)—ou mieux noyaux *strepsitènes* ou *strepsinema* (Dixon, 00, Grégoire, 07), cette dernière expression rappelant les entrelacements caractéristiques de cette periode." ("Les cinèses de maturation dans les deux règnes" (second memoire). *La Cellule*, 26, 2, p. 239; 1910.) Grégoire, so far as I can discover, uses the term 'strepsinema' here for the first time.

With regard to the process of lateral approximation and twisting together of the separate chromosomes, now known to be homologous, and generally recognised as a normal stage of meiosis, I believe I was one of the first, if not the first, to observe and to describe it (*Proc. R.I.A.*, 1895 and "Notes from the Botanical School, T.C.D.", 1896). In this connexion I may again quote Grégoire: "La même année (1895) Dixon donne une interprétation toute différente. . . . Pour lui, les deux moitiés entrelacées qui constituent chaque chromosome, au moment où s'isole du peloton, ne sont pas le résultat d'une division longitudinale mais représentent deux tronçons du peloton qui, dès avant la segmentation transversale de ce dernier, se sont rapprochés et entrelacés. ("Les cinèses polliniques chez les Liliacées". *La Cellule*, 16, 2, p. 241; 1899.) Again p. 250: "Tous les auteurs, . . . , à part Dixon, décrivent cette division longitudinale. Dixon, au contraire, considère ces deux portions enroulées comme deux tronçons du peloton qui se seraient rapprochés et entrelacés." The view I put forward then is now generally accepted by cytologists, Grégoire included.

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Variation Effect in Latitude, Correlatable with the Moon

IN NATURE of January 26, 1929, p. 127, a communication appeared dealing with the variation of latitude with the moon's position. Attention was directed to small variations of less than a tenth of a second of arc, determined from Gaithersburg observations, which appeared to be correlated with the hour angle and altitude of the moon. While in this preliminary note a marked dependence was exhibited of the magnitude of the latitude residuals upon the moon's position with respect to the observer at the time the zenith telescope observations were made, no direct attempt was made to separate the dependence of the moon's hour angle from that of the moon's declination.

Studies of the small variations in latitude (corrected for the 428-day term) have been systematically continued for other stations and years, yielding results of increasing interest.

Reductions have now been carried out for four of the international latitude stations for the years 1909–11, and the resultant residual variations in latitude grouped both by hour angle and declination

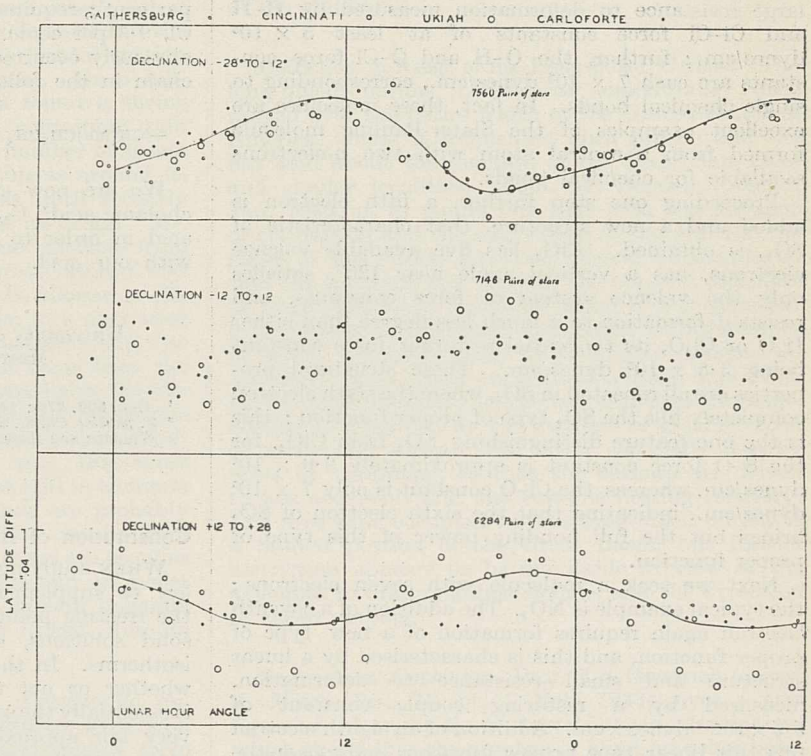

FIG. 1. Variation in latitude with the moon's hour angle and declination, 1909–11.

of the moon. The accompanying graph (Fig. 1) shows the results for north declination, south declination, and for the time when the moon is near the equator between − 12° and + 12°.

The resemblance of these curves to diurnal curves of equilibrium tides appears to give confirmatory evidence for an earth tide hypothesis. The inversion of phase for the change in the moon's declination is particularly significant in this respect.

The magnitude of the effect observed being 5–10 times greater than on the basis of our present knowledge of earth tides, suggests a possible mobility in the earth's crust at right angles to gravity. Some such hypothesis appears consistent with the results of tilt experiments, such as that of Michelson and Gale, and the displacements of the zenith here recorded in astronomical observations.

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Jan. 24.

Structure of Triatomic Molecules

RECENT investigations of infra-red and Raman spectra of triatomic molecules have shown that molecules with an odd number of electrons, such as ClO_2 and NO_2, are similar in structure to the molecules SO_2 and CO_2, each with one more electron. This observation suggests that the triangular molecules have structures depending on the number of valence electrons binding the three atoms together, and that a scheme might be formulated for obtaining the structures of these molecules from the total number of available valence electrons.

A stable structure is first obtained with four electrons. Examples are H_2O and Cl_2O, molecules which have surprisingly similar structures: both have vertical angles near 90°, both satisfy only the central system of force constants, and both show a large resistance to deformation measured by H–H and Cl–Cl force constants of at least 5×10^5 dynes/cm.; further, the O–H and O–Cl force constants are each 7×10^5 dynes/cm., corresponding to single chemical bonds. In fact, these molecules are excellent examples of the Slater-Pauling molecule formed from a central atom with two *p*-electrons available for chemical bonds.

Proceeding one step further, a fifth electron is added and a new structure, that characteristic of SO_2, is obtained. ClO_2 has five available valence electrons, has a vertical angle near 120°, satisfies only the valence system of force constants, and resists deformation to a much less degree than either H_2O or Cl_2O, its tangential restoring force constant being $3{\cdot}5 \times 10^5$ dynes/cm. These structural properties are all repeated in SO_2, where the sixth electron completely fills the SO_2 type of proper function; this is the one feature distinguishing SO_2 from ClO_2, for the S–O force constant is approximately $9{\cdot}6 \times 10^5$ dynes/cm. whereas the Cl–O constant is only 7×10^5 dynes/cm., indicating that the sixth electron of SO_2 brings out the full bonding power of this type of proper function.

Next we seek a molecule with seven electrons; the typical example is NO_2. The addition of a seventh electron again requires formation of a new type of proper function, and this is characterised by a linear structure and small resistance to deformation, measured by a restoring couple constant of $5{\cdot}5 \times 10^{-12}$ dynes × cm. Addition of an eighth electron fills this linear type proper function, and raises the force constant of the chemical bond from 7×10^5 to 14×10^5 dynes/cm. Addition of the eighth electron does not otherwise affect the structure, the similarity of the restoring couple constants being a remarkable feature of the linear molecules NO_2, N_2O, CO_2, COS and CS_2. The C–S force constant is less than 14×10^5 dynes/cm., and may be accounted for by the increased separation of the nuclei.

The above scheme seems also applicable to triatomic radicals, and has been used to explain apparently inconsistent structures observed for the NO_2 group[1]. It also predicts an SO_2 structure for NOCl, and preliminary observations of the infra-red absorption spectrum appear to confirm this.

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Feb. 22.

[1] Bailey and Cassie, NATURE, **131**, 239, Feb. 18, 1933.

Hydroxyl Group in Ergosterol and Cholesterol

IN a recent issue of the *Annalen*[1] is a paper by Chuang in which the conversion of ergostane into *allo*-norcholanic acid, $C_{23}H_{38}O_2$, is described. This result is of considerable interest as it definitely establishes the identity of the nuclear skeletons of ergosterol, cholesterol, and the bile acids.

We have also been investigating the same question with the additional object of determining simultaneously whether the hydroxyl group in ergosterol is in the same position as in cholesterol which, as has been shown by Wieland and Dane[2], is almost certainly attached to carbon atom 3. With this object in view we have oxidised ergostanyl chloride, $C_{28}H_{49}Cl$, with chromic anhydride and have isolated a chloro-acid, m.p. 213°, analysis of which shows that it is a chloro-norcholanic acid (found: C, 72·7; H, 10·0; Cl, 9·7 per cent; required for $C_{23}H_{37}O_2Cl$: C, 72·5; H, 9·7; Cl, 9·3 per cent). The formulation of this acid has obviously occurred by scission of the ergostanyl side-chain in the following manner:—

$$-CH(Me)CH_2CH_2 \,|\, CH(Me)CHMe_2 \rightarrow -CH(Me)CH_2COOH$$

We are now engaged in degrading 3-chloro-*allo*-cholanic acid[3], $C_{24}H_{39}O_2Cl$, to the corresponding nor-acid in order to establish its identity or otherwise with our acid.

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March 17.

[1] *Ann.*, **500**, 270; 1933.
[2] *Z. physiol. Chem.*, **212**, 41; 1932.
[3] Windaus and Hossfeld, *Z. physiol. Chem.*, **145**, 177; 1925.

Constitution of Binary Alloys at Room Temperature

WHEN studying binary organic melts, it is customary to supplement the information obtained from the freezing point curve as to compound formation, solid solutions, etc., by examining the solubility isotherms. In this way, not only can it be decided whether or not the composition of a cold mixture is essentially the same as at its freezing point, but also a very fair approximation to the transition point of a compound can often be obtained by means of a solid model or projection diagram. For the purpose of the solubility measurements, the nature of the solvent is considered immaterial and solvation is not supposed to affect the range of stability of the compound.

This being the case, it occurred to me that a similar procedure might be applied with equally reliable results to binary alloys, using mercury as solvent, and plotting the results on a triangular co-ordinate diagram. Mr. H. D. Carter, working in my laboratory on the system mercury–manganese–tin, at 30°, is obtaining results which show that the procedure is feasible. Dilute tin amalgams are used as cathodes and manganese electro-deposited up to the appearance of solid phase. Perhaps the method may become of general application in metallurgical work.

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Research Items

Archæological Discoveries in Uganda. Mr. E. J. Wayland figures and describes in *Man* for February relics of a culture at present unidentified from a site at the top of Luzira Hill, Port Bell, Uganda, of which the first indications were some remarkable heads of pottery figures found by natives in the course of building operations. A stratum of angular granite rubble, thought to be of middle Pleistocene or post-middle Pleistocene age, was found to contain artefacts belonging to two groups, one contemporaneous, the other derived. In a stratum of red earth above, were elongated continuations of the surface soil which were found to contain parts of pottery figures and a number of fragments of pottery vessels, all of which had been broken before being deposited in the pits. The pits were circular in horizontal section and showed no sign of any interment. On a hill-top a quarter of a mile away was found a shrine consisting of an earthenware pot containing rain water and a few coins and having a number of spears arranged point inward and other objects around it. Although the shrine is still or was until recently in use, the natives know nothing of its origin. Mr. Miles Burkitt, reporting on the stone artefacts from Luzira, considers the industry of great interest and compares it with that found by F. B. Macrae in the Kafue district of Northern Rhodesia, in a cave near Mumbwa. Mr. H. J. Braunholtz considers that the objects from the pits are older than those from the shrine. The pottery figures are remarkable for the head-dress and also for the conventional treatment of the body. In one figure the thighs are omitted. The figures are unique in African art. One small fragment of pottery has an ornament still in common use among the Baganda. These finds are probably only a few centuries old. Among the objects from the shrine the iron spear heads with tangs are peculiar for Uganda, while those with sockets and an eyelet between blade and socket are not a modern Baganda type and cannot be matched in the British Museum collections.

Ceremonial Exchange in Polynesia. Ceremonial exchanges of gifts, frequently mentioned by writers on Polynesia, apparently are quite meaningless from the economic point of view and indeed at times the gifts exchanged are of the same kind. A study of these ceremonial exchanges in Ontong Java, the Polynesian community in the Solomon Islands, by Dr. Ian Hogbin in *Oceania* (vol. 3, pt. 1) shows, however, that benefits are derived from these exchanges in various ways and that their uselessness is more apparent than real. In Ontong Java elaborate exchanges of food take place on various occasions. In betrothal, the most important, the father of the girl announces the fact to the head of his family group, through whom the announcement is conveyed to the headman. The headman immediately gives orders that the women of the group are to collect taro, which is brought to the house of the mother. The father and mother's brother in the meanwhile collect a number of coco-nuts, and a pudding is made, which when cooked is distributed among the women of the two groups concerned. The father of the boy also announces the betrothal to his headman, who decides how many coco-nuts are to be collected and gives orders for the men of the group to collect the nuts and also fish. The boy's mother's brother's group also collect nuts. The points to be noted in these exchanges are that, apart from any question of material gain, they bring the headman and the father prestige, and afford an outlet for pride and vanity without harm to other members of the community; they form a bond and impose a mutual obligation on two groups of the society as well as between individual members of the group; they emphasise the mutual relations of the head of the group and the individual member; and they also serve to stabilise marriage. They legalise the marriage, and establish the legitimacy of the children.

Restriction in Range of the Long-Billed Curlew. The long-billed curlew (*Numenius americanus*) once ranged over the entire width of the United States of America, where it frequented open prairie and the flat land about the marshes of the Great Salt Lake and similar localities. John W. Sugden (*Condor*, Jan. 1933, p. 3) points out that with the advance of civilisation and the cultivation of the prairies, the range of this curlew has been pushed westwards, so that the numbers now seen on the marshes and flats of Great Salt Lake represent rather a concentration in a restricted range than an increase in the number of birds. Actually there is a notable decrease in numbers. Even where cultivation is made impossible by the high alkalinity of the soil and poor drainage, nesting is disturbed by the increase of grazing stock of cattle and sheep. The latter especially destroy nests by trampling, so that the curlews are driven to less accessible and less suitable nesting territory. The area now occupied by the long-billed curlew is a limited portion of the Great Basin, but further restriction appears to be inevitable in view of the attempts to drain alkaline sloughs and the extension of sheep ranging.

Nephridia of *Amphioxus*. Prof. E. S. Goodrich (*Quart. J. Micro. Sci.*, 75, pt. 4, Feb. 1933) gives a new figure of the nephridia of *Branchiostoma* (*Amphioxus*) which shows that the number of blind branches bearing solenocytes is considerable and that the anterior canal attached to the primary gill-bar may be more than 0·3 mm. long. The paired nephridia of the allied genus *Asymmetron* (*A. lucayanum*), which were studied at the Biological Station, Bermuda, are built on the same plan as those of *Branchiostoma* but are smaller and simpler. From the pore, which opens into the atrium near the top of the secondary bar, the canal runs dorsally and expands into a triangular sac from the dorsal edge and outer surface of which the solenocytes chiefly arise. The solenocytes are rather larger than those of *Branchiostoma* and the tube of each, down which works a long flagellum, may reach a length of about 0·04 mm. The paired nephridia are retroperitoneal but the coelomic epithelium is interrupted and does not cover the solenocyte field so that coelomic fluid bathes the solenocyte tubes. The blood supply of the nephridium seems to be much less developed than in *Branchiostoma* and the conspicuous network of blood-capillaries described in the latter by Boveri is represented by only a few slender vessels in *Asymmetron*. In

Asymmetron as in *Branchiostoma*, Hatschek's unpaired nephridium is present, extends along the lateral wall of the left dorsal aorta and opens posteriorly and dorsally into the pharynx by a small pore just behind the velum. This nephridium reaches forwards slightly beyond Hatschek's pit and in the adult is nearly 2 mm. long. Along the course of the slender main canal are small dorsal and ventral solenocyte chambers into which penetrate branches of solenocytes from diverticula of the canal.

Late-Blight of Tomatoes. The fungus *Phytophthora infestans* is well-known in Great Britain for the damage it causes to the potato crop. In many parts of the United States it is also a serious menace to the extensive fields of tomatoes. Circular No. 169 of the United States Department of Agriculture ("Tomato Late-Blight Rot, a Serious Transit and Market Disease" by G. B. Ramsey and Alice A. Bailey, 10 pp.) describes the disease in detail. The symptoms are superficially like those of potato blight. Leaves are blackened and hang down from the stems, which in turn fall over. Wet seasons induce the abundant production of mycelium over the surface of affected parts. Fruits are also attacked, with the formation of watery brown places which may gradually extend all through the tomato. The fungus is capable of developing very quickly amongst fruit packed for transit, and large losses have been recorded at this time, though very little spread occurs from one fruit to another. Various treatments of freshly-picked fruit with water and with weak formaldehyde solution have failed to arrest development of the rot during transit, but spraying with Bordeaux mixture is a preventative when applied to the growing plants.

Differentiated Sills in Skye. The lower members of the great group of basic sills intrusive into the Jurassic strata of the coast of Northern Trotternish (Skye) form the subject of an investigation by Dr. F. Walker (*Trans. Roy. Soc. Edin.*, 57, No. 7, 1933). Ophitic olivine-dolerite is the most widespread type of rock, but there is a noteworthy development of picrite in the thicker sills. Gravitational settling of olivine crystals can be clearly demonstrated in the well-known sill that forms the Kilt rock, and the process is thought to have occurred in other sills. In some examples, instead of a comparatively thin layer rich in olivine near the base, picrite occurs as the most abundant rock with relatively thin olivine-dolerite margins. It is shown that the lower members of the visible suite of sills contain considerable amounts of ultrabasic rock, and it is argued that differentiation must have been drastic in the feeding reservoirs, producing great accumulations of peridotite of which the Trotternish sills reveal samples. The recent suggestion that the non-porphyritic central magma type represents the parental magma of the Tertiary igneous rocks of this province is discussed. It is pointed out that it would seem to imply the production of a great preponderance of quartzose types over basic rocks of plateau magma type. Such preponderance is not indicated by the existing field evidence, which is thus at variance with the suggestion.

Soundings in the Scotia Sea. The waters of the Southern Ocean between Drake Strait and the South Sandwich Islands, west and east, and between the Falklands and South Georgia on the north and the South Shetlands and the South Orkneys on the south, are now known as the Scotia Sea in honour of the work of Bruce's expedition in the *Scotia* in that area. They would appear to be surrounded, except on the west, by a great hairpin ridge, partially submerged, which was originally known as the South Antillean Arc but is now called the Scotia Arc. Many thousands of soundings taken in this region by *Discovery II* and associated ships are recorded on charts published in "Discovery Reports", vol. 6. "Report on Soundings taken during the Discovery Investigations 1926–1932". By H. F. P. Herdman (Cambridge University Press, 15*s*.). Most of the soundings were taken by the echo methods, which admitted of seried rows of soundings where formerly the scattered observations of *Scotia* and *Antarctic* were almost the only data. Mr. Herdman discusses the probability of the Scotia Arc being a line of folding and shows that the weight of evidence, both oceanographical and geological, is in favour of a structural connexion between South America and Graham Land. Folded large-scale charts are provided in a separate case and coloured bathymetrical charts, which show earlier soundings also, are bound into the report.

Isotopes of the Radio Elements. The *Physical Review* for January 1 contains several papers describing applications of the Allison magneto-optical method to finding metallic isotopes. This method consists in observing the Faraday magneto-optical rotation produced by solutions of the metallic salts and measuring the lag between the application of the field and the appearance of the optical effect. The light from a spark is polarised and passed through cells over which are wound magnetising coils fed with high-frequency currents from the spark circuits. One of the cells contains the solution under investigation, and the other contains a comparison liquid. The coils produce opposite rotations and the occurrence of a characteristic time of lag is detected by a minimum in the light intensity as the optical path between the cells is changed. Even with very dilute solutions, it is claimed that the presence of molecules of a particular isotopic variety makes itself evident by the occurrence of a characteristic lag. In the papers under notice, the method is applied to lead (sixteen isotopes), bismuth (fourteen isotopes), radium (four isotopes), uranium, thorium and thallium (eight isotopes each). The abundance of the isotopes in the specimens was estimated from the minimum concentrations in which the characteristic lags could be observed. On the basis of the isotopic constitutions found for these elements, Edna R. Bishop constructs a table of the radioactive elements and their relations which is in good accord with the known facts of radioactivity.

Philips Sodium Lamp. A notable improvement in the efficiency of certain sources of monochromatic radiations has resulted from the recent development of the hot-cathode discharge tube. An interesting example of the new type of source is the Philips sodium lamp, a specimen of which has been submitted to us by Philips Industrial, 145 Charing Cross Road, London, W.C.2. The lamp consists of a small glass envelope containing a coiled filament, which constitutes the cathode, two other ring-shaped

electrodes, and small quantities of inert gas and sodium. The lamp operates from A.C. mains, of voltages from 215 to 230, in association with a rectifier which provides heating current for the filament and the requisite low voltage for the glow discharge. The visible spectrum of the lamp immediately after starting is due chiefly to the inert gas, but the heat generated by the discharge vaporises some of the sodium, and the spectrum of sodium gradually supersedes that of the gas. Maximum brilliancy is attained within 10–15 minutes after starting the lamp, and the spectrum then consists entirely of sodium lines, the yellow *D* lines being by far the most intense. The other lines, situated in red, green and blue regions, can be removed, or reduced to very low intensity, by using a yellow gelatine filter or a potassium bichromate cell. The brightest portion of the source consists of a central cylinder about 2·5 cm. long and 2·5 cm. in diameter. A Dewar flask and a polished metal radiation shield are provided with the lamp for maintaining it at the appropriate operating temperature. The lamp is simple to operate, provides a highly intense and steady source of the *D* lines, and has many obvious laboratory applications, particularly in colorimetry, polarimetry and refractometry.

Detection of Traces of Carbon Monoxide in Air. The extremely poisonous character of carbon monoxide and its presence in the exhaust gases of motor-car engines render the easy detection of traces of this compound a necessity of modern life. The lowest concentration of carbon monoxide in air which will produce fatal results when breathed is said to be not greater than 0·1 per cent and has been computed by Hempel to be about 0·05 per cent. In the *Chemiker-Zeitung* of February 25, Dr. W. Ackermann of Breslau describes the results of comparative tests made with the two reagents which have hitherto been regarded as being most sensitive to carbon monoxide, namely, diluted ox-blood and palladous chloride. Hæmoglobin is said to absorb carbon monoxide about 130 times as readily as oxygen, but differentiation between the absorption spectra in the two cases is only possible after the addition of a reducing agent (ammonium sulphide), when the characteristic bands disappear unless carbon monoxide has been absorbed. On the other hand, the gas reduces palladous chloride very readily to the free metal and the colour and transparency of the reagent may be observed during the whole course of the experiment. Even when no deposit can be seen by the naked eye, its presence can sometimes be revealed by filtering the solution. The results are very striking. By passing 1 litre of air containing varying small amounts of carbon monoxide through the reagents for one hour, it was possible to detect 0·015 per cent of the gas by the palladous chloride method, as against 0·13 per cent by the hæmoglobin method.

Astronomical Topics

Geddes's Comet. This comet has now been observed for more than eight months, but is still a fairly easy object, and is likely to be followed for most of 1933, if not longer. *Astronomische Nachrichten*, No. 5934, contains a fine series of observations extending from June to December, made by J. Tretter at Cordoba Observatory (Argentine).

The comet is now in north declination 10°, and is observable for most of the night. Since its orbit is probably hyperbolic, it is important to keep it under observation. It was observed by M. Beyer at Hamburg on March 1. It was an oval nebulosity 2′ in diameter, the combined light being of mag. 9·7, and the nucleus of mag. 11·6. An ephemeris for the whole year is given in the Handbook of the British Astronomical Association for 1933; the error of the ephemeris does not exceed 2′ or 3′.

Variable Stars in the Globular Cluster M.53. It was the study of cluster-variables that led to the important law correlating period with absolute magnitude; this law permitted determinations of distance to be made in the case of objects beyond the range of all previous methods. Herr E. Grosse, of the Bergedorf Observatory, has made a study of the variables in Messier 53, in Coma Berenices (*Astr. Nach.*, 5901). Light curves are given for thirty-four variables. Most of these are of the characteristic cluster type, with rapid rise and slow decline, but a few of them conform more closely with regular sine curves.

The distance of the cluster is determined as 19,500 parsecs; Prof. Shapley had found 18,200 parsecs by rougher methods (diameter of cluster, total light, and magnitude of brightest stars). Grosse's value places the cluster 3,700 parsecs from the galactic plane. Its diameter was reckoned from the angular distance of the outer variables from the centre, and found to be 89 parsecs, about the same as Messier 3 and Messier 5. It is estimated that 7 per cent of the stars in M.53 are variable; in ω Centauri the percentage is 4, in M.3 it is 15.

Minor Planets. The volume of "Kleine Planeten" for 1933, just published by the Berlin Rechen-Institut, gives evidence of the zeal of many astronomers both in discovering new planets and in keeping the known ones sufficiently observed. The planets with permanent numbers now extend to 1,223, having increased by 40 during the year. Each year a list is given of planets for which observations are specially desired. 35 of the objects thus listed last year have been re-observed. Orbit elements are given for all the numbered planets. Dr. Witt gives a revised orbit of 433 Eros, which he discovered in 1898; the new elements, for 1925, Jan. 1·0 U.T. are: M 204·560°, ω 177·945°, Ω 303·710°, *i* 10·830°, Φ 12·879°, *n* 2,015·258″, *a* 1·4581. The interesting planet 944 Hidalgo, which travels out to Saturn's orbit, has been out of sight for ten years; it may possibly be seen by southern observers next September, its magnitude being 15·4.

The remarkable planet discovered by M. Delporte a year ago, which approaches the earth within ten million miles, has now the number 1,222, and the name Amor; an ephemeris is given for next October, but as its magnitude is 21, its recovery can scarcely be expected. The tenth Trojan planet, 1,208 Troilus, was in opposition on December 31, 1932, in north declination 55°, magnitude 15·2. Eros is in opposition on June 27 in south declination 36°, magnitude 11·1.

The New Compressed Air Wind Tunnel at the National Physical Laboratory

THE new compressed air tunnel for aeronautical research at the National Physical Laboratory, recently completed and now being brought into use, is the largest and most up-to-date of its kind, and the second one only in the world. A small tunnel on the same principle has been working in the United States for several years, and the British one has incorporated in it many new features found desirable during the use of this earlier type.

The theoretical basis of the new compressed air tunnel at the National Physical Laboratory is to be found in Rayleigh's law of dynamical similarity, upon which the validity of all model research in aerodynamics rests. This law may be written

$$R = \rho v^2 l^2 f(vl/\nu)$$

where R is any particular aerodynamic reaction, for example, the lift or the drag of a model aeroplane, v is the relative speed, ρ is the air density, l is a characteristic length of the model, ν is the coefficient of kinematic viscosity of the air, and $f(vl/\nu)$ represents some function of vl/ν which cannot be determined theoretically. The implication of this law in predicting full-scale characteristics from model tests is obvious. Thus if the model is tested at atmospheric pressure and temperature, the only way to be absolutely certain of predicting full-scale forces accurately is to test at the same value of the product vl.

A simpler approach to tests under these conditions, except in the matter of size, is seen in the very large wind tunnel, having a jet measuring 60 ft. × 30 ft., recently erected in the United States. Testing on such a large scale is very convenient for some purposes, but for most branches of research it is preferable to work with smaller models. In many cases the variation of the function $f(vl/\nu)$ with scale is not serious, so that tests in an ordinary atmospheric pressure wind tunnel of moderate size give all the accuracy required. Ample justification for ignoring changes in $f(vl/\nu)$ between tunnel and full-scale has now been provided by the agreement between full-scale flying measurements and model results obtained in such tunnels. But in some instances, notably the maximum lift coefficients of aerofoils, there may be a pronounced 'scale effect', that is, change in $f(vl/\nu)$ with scale or speed. It is here that Rayleigh's law provides a relatively simple solution, for the quantity ν varies inversely as the pressure, so that if the air is compressed to n atmospheres, the model scale by speed product can be reduced in the ratio $1/n$ without affecting the value of $f(vl/\nu)$. This principle is made use of in the new compressed air tunnel, in which the air can be compressed to 25 atmospheres. The maximum wind speed in the six-foot diameter jet is about 60 miles per hour, so that tests at full pressure on a 1/10 scale model simulate precisely the conditions of the full-scale aircraft flying at 150 miles per hour.

The working section in which models are tested is 6 ft. in diameter. The air flowing through this section returns through an annular space surrounding it, being circulated by a fan. This requires a diameter of 17 ft. for the containing shell, which is made of steel nearly 2½ in. thick. The shell was designed and made by Messrs. John Brown and Co. Ltd., of Sheffield, and consists of four rings, each rolled from a single ingot, and jointed together by circumferential straps fitting over slight flanges on the ends of the rings. The four rings together form a cylinder 17 ft. in internal diameter and 32 ft. long. The ends of this cylinder are each completed by two steel castings forming a hemisphere. At one end is a special labyrinth packing through which the fan shaft passes to the external driving motor, while the other end has a door for access to the tunnel. The internal air passages forming the wind tunnel itself were designed at the National Physical Laboratory by tests on a small model, modifications being made until the uniformity of the air flow was satisfactory. In the actual tunnel, the internal structure is built entirely in steel, light castings being used in the curved portions, and steel plates on suitable framing in the straight parts. A honeycomb is introduced at the point of lowest air speed to straighten the flow, and is immediately followed by a rapid contracting jet just before the working section is reached. This results in very steady and uniform distribution of speed across the working section. The air is circulated by a metal airscrew or fan driven by a 400 h.p. motor. Air is compressed into the shell by three 400 h.p. compressors housed in an adjoining room, and capable of charging the shell to the full pressure of 25 atmospheres in about ninety minutes.

An observer cannot work inside the tunnel at this high pressure, and the readings of the balances on which the models are suspended have to be recorded outside. This is done by an extremely interesting and unique electrical apparatus which can transmit the readings to any point as desired. The air forces to be measured are balanced by electromagnetic attractions between coils of wire, the current in which is controlled from outside. The current required for balance is measured and thus gives a direct indication of the air force acting on the model. Certain movements of the model are also made by electric motors controlled from outside the tunnel.

Selectivity and Radio Communication*

IT has long been a commonplace remark that one of the greatest problems in the technique of radio communication is the avoidance of the reception of undesired signals. Improvement and developments in methods of reception have made it comparatively easy to receive intelligible signals from almost any transmitting station under a variety of conditions, but these methods increased rather than reduced the difficulties of eliminating interference due to signals emanating from stations other than the one from which it is desired to receive. For telegraphic communication the difficulty has in the past been partially overcome by increasing the selectivity of the receiving circuits so far as stability would permit, but the use of shorter wave-lengths and of directive aerial systems has also contributed to the solution. With the inception of broadcasting and

* F. M. Colebrook: "A Theoretical and Experimental Investigation of High Selectivity Tone Corrected Receiving Circuits", Radio Research, Special Report No. 12. (London: H.M. Stationery Office, 1932.) 1*s*. 3*d*. net.

the rapid development of emitting stations in restricted geographical areas, the effects of radio interference have been brought home to a much wider public.

On a first inspection of the problem as applied to the reception of speech and music, as in telephony or broadcasting, it appeared that the relatively high selectivity of the telegraphic circuits could not be utilised on account of the distortion which would arise from the loss of the higher note frequencies in the audible range. Recent research has shown, however, first, that the problems of the reduction of interference are the same in all branches of radio communication; and secondly, that the correct application of existing knowledge on radio frequency circuit operation can be of considerable assistance in reducing the interference experienced in any conditions of radio reception.

On account of the importance of this subject, the Radio Research Board appointed a special committee, under the chairmanship of Prof. E. V. Appleton, to report on the properties of very highly selective radio receivers. On behalf of this committee, Mr. F. M. Colebrook carried out a theoretical and experimental investigation of the subject, and the results of this work, together with the committee's considered conclusions on the problems involved, are contained in a report recently published by the Department of Scientific and Industrial Research.

In the course of this investigation the general problem of the reception of modulated electrical oscillations in a circuit of known constants has been considered in a comprehensive manner. The research has been limited in the first place by the assumption of quasi-stationary conditions, and it is realised that the results of imposing transient conditions will need further consideration. Moreover, the investigation was specially directed to studying the behaviour of a circuit of high selectivity, that is, a tuned oscillatory circuit in which the current amplitude falls very rapidly as the frequency of the inducing electromotive force is displaced by comparatively small amounts from its resonant value. The practical application of this work consists in the use of such a high selectivity circuit as part of the apparatus employed for receiving modulated radio signals in the presence of similar signals at neighbouring radio frequencies which it is not desired to receive. The distortion already referred to which results from the gradual amplitude reduction with increasing modulation frequency may be corrected for by using one or more audio-frequency stages in which the amplification obtained increases with the frequency in the requisite manner.

In the case postulated, the desired signals may be assumed to consist of a carrier wave with associated side waves due to telephonic, telegraphic, or other modulation, and it is by the combination of the effects of these waves in the receiver in their correct phase relationships that reception takes place. Under the conditions stated above, the total interference can be classified into two groups. The first includes all interference which would exist even in the absence of the carrier wave of the wanted transmission. A familiar example of this is the reproduction in a broadcasting receiver tuned to a certain station of the programme of another station transmitting on a neighbouring frequency or wave-length. The second group comprises all interference which would disappear completely if the carrier wave of the wanted transmission were removed. The most important and familiar example of this type of interference is the steady heterodyne beat note resulting from interference between the carrier waves of the wanted and unwanted transmissions.

The results of the investigations of this case show that, by the use of a highly selective receiving circuit in combination with a suitable tone-corrected audio-frequency amplifier, interference of the first type can be reduced to almost any desired extent within certain practical limits of circuit and transmission frequency stability. In the case of interference of the second type, however, the position is totally different in that the magnitude of this interference is independent of circuit selectivity, the relative reduction of interference in the selective circuits being removed by the subsequent tone correction. On account of the presence of this second type of interference, the frequency difference between the carrier waves of the wanted and unwanted transmissions must be at least twice as great as the audio-frequency range it is required to cover in the modulation signals transmitted and received. The advantage to be gained by the reduction of the first type of interference is considerable, and it is likely that the principles, now well established, will attract considerable attention in the future of radio receiver design and practice. The principles apply equally to all classes of receiving apparatus, whether these are for broadcast reception, for telegraphic reception using Morse code signals, or for the reception of those modulation signals which are employed in television and picture telegraphy.

The Priestley and Pepys Commemorations

WHEN Priestley on April 8, 1794 left the shores of England to seek an asylum in the United States, he could little have thought that nearly a century and a half later his name would be on everybody's lips and that men of light and learning would gather together in many places to pay tribute to his memory. After fleeing from Birmingham in 1791 in fear of his life, he had reached London only to find himself shunned by many of his fellow members of the Royal Society, and as the French Revolution, for which he had at first had much sympathy, reached its climax, his position had become so unpleasant, if not hazardous, that he was driven to the conclusion that his removal would be of more service to the cause of truth than his longer stay in England.

Thus it came about that just a month before France saw her greatest man of science fall beneath the guillotine, England allowed one of her noblest sons to become a voluntary exile. To-day, however, the name of Priestley, like that of Lavoisier, is held in honour throughout the world and the celebrations which have recently taken place in London and elsewhere have done much to atone for the neglect shown him in his later years.

Of these celebrations the most important was that of March 15, when at Burlington House the president of the Royal Society, Sir Frederick Gowland Hopkins, held a reception to commemorate both the bicentenary of the birth of Joseph Priestley and the tercentenary of the birth of Samuel Pepys. Needless

to say, the rooms in which Sir Frederick received the guests were not the apartments known to Priestley, for when in 1773 at the hands of Sir John Pringle he received the famous Copley medal, the Society was still housed in Crane Court, whence, seven years later, it removed to Somerset House. But no doubt Priestley would have found much with which he had once been familiar, for when he was admitted a fellow of the Society in 1766, the Society was more than a hundred years old, and among the exhibits open to the visitors on March 15 was the Charter Book signed by all fellows.

The most interesting exhibits at the Royal Society's reception were those relating to Priestley himself, gathered together from many sources. Among these were to be seen a letter in French intimating to Priestley that he had been nominated for the National Convention, an honour he wisely and firmly declined; the diploma and seal given to him by the Empress Catherine II of Russia and his Copley medal, presented with such graciousness by Sir John Pringle, who remarked that the Society awarded it to him "as a faithful and unfading testimony of their regard, and of the just sense they have of your merit, and of the persevering industry with which you have promoted the views, and thereby the honour of the Society". The diploma, seal and medal were recently bequeathed to the Society by one of Priestley's great-granddaughters and it was to a great-great-granddaughter, Mrs. Belloc Lowndes, that the Society was indebted for the loan of some of the other exhibits, including the letter referred to. Most of Priestley's books, manuscripts and apparatus were destroyed in the fire at Birmingham in July 1791. Another exhibit of great interest was a series of documents, hitherto unpublished, lent by Lord Lansdowne. Beside the Priestley exhibition, there was also a small collection of documents recalling Pepys's connexion with the Royal Society. During the evening Sir Harold Hartley gave an address on Priestley's work.

The Priestley bicentenary was also commemorated in the provinces and his association with Lancashire, Yorkshire and Warwickshire was recalled by articles in the *Manchester Guardian*, the *Leeds Mercury* and the *Birmingham Mail*. His connexion with Leeds was a very close one, for he was born at Fieldhead, close to the city, he attended Batley Grammar School, and in 1767 became the minister of Mill Hill Unitarian Chapel. On March 11, therefore, the Old Boys' Association of Batley Grammar School had a Priestley commemoration dinner at the Hotel Metropole, Leeds, and on the following day a special service was held in Mill Hill Chapel, which was attended by the Lord Mayor of Leeds, Alderman R. H. Blackburn, and members of the Leeds Philosophical Society. During the course of his sermon, the Rev. W. L. Schroeder, referring to Priestley's statue in the city square, said it was symbolic of Priestley's endeavour to bring the light of truth within the reach of all; adding that though most people thought of Priestley as a man of science, it was more important that he was a minister, all of whose activities were devoted to the glory of God and the happiness of mankind.

The Chemical Society will commemorate the Priestley bicentenary by a special meeting in its rooms at Burlington House, London, W.1, on April 6 at 8 p.m., when papers will be read by Prof. A. N. Meldrum, Sir Philip Hartog and Sir Harold Hartley.

University and Educational Intelligence

CAMBRIDGE.—Mr. W. J. Courtauld has provided the sum of £6,000 for the repair of glasshouses in the Botanic Garden.

Sir Charles S. Sherrington will deliver the Rede lecture at 5 P.M. on May 24. The subject will be "Mechanism and the Brain".

Prof. B. L. Van der Waerden will deliver the Rouse Ball foundation lecture on April 24 at noon. The subject will be "The Aims of Modern Algebra".

It has been recommended that Dr. U. R. Evans be appointed assistant director of research in metallurgy for the period during which he holds the Royal Society Armourers and Braziers' research fellowship in metallurgy; and that the post of assistant in experimental research in crystallography be established in the Department of Mineralogy and Petrology for F. I. G. Rawlins, of Trinity College.

C. C. Hurst, of Trinity College, and A. F. Hallimond, of Pembroke College, have been approved for the degree of Sc.D.

WALES.—The Council has accepted with regret the resignation of Dr. S. Dickinson, assistant lecturer in botany at the University College of South Wales and Monmouthshire, Cardiff, on his appointment as research assistant in mycology in the Department of Agriculture in the University of Cambridge.

WITH the twenty-first volume, recently published, the series of "Methods and Problems of Medical Education" issued by the Rockefeller Foundation of New York is for the time being brought to a close. This series was begun in 1924 and has comprised volumes of articles devoted to descriptions of teaching facilities and methods in the field of medical education. The present volume deals with nursing education and schools of nursing, and several institutions in the United States and Canada, Peiping and Bangkok, are described and illustrated. Articles on nursing education in England, Denmark, Finland, France and Hungary are also included.

BILINGUALISM and the employment as a medium of instruction and examination of a language other than the mother tongue of the student give rise to problems of educational administration in many parts of the British Empire and especially in India. Some of these problems are dealt with in a report recently published by the Government of India, Central Publications Branch, Calcutta (pp. 48, price As. 10 or 1*s*.) on the use of the mother-tongue in the matriculation examination of the University of Bombay. It appears that since 1925, matriculation candidates have been permitted to write either in English or in their mother-tongues their answers in history and in Indian classical languages, and the proportion of candidates who have availed themselves of this option to write their history answers in their mother-tongue has steadily increased from one fifth in 1926 to two thirds in 1931, although more than half of the students in the high schools in the Presidency are receiving instruction in English. An analysis of matriculation results goes to show that those who answered the history papers in their mother tongue as a rule gained higher marks than the others but did badly in English.

Calendar of Nature Topics

The 'Borrowed Days'. The Blackthorn Winter

March 29–31.—The last three days of March are said to be marked by unusually fierce winds, sleet, snow and frost. The legend, widely spread in various forms, is that March borrowed them from April to extend his sway. In a Spanish version quoted by Inwards, a shepherd promised March a lamb if he would temper his winds, but after gaining his point refused to pay over the lamb; in revenge March borrowed three days from April, in which fiercer winds than ever blew. The 'blackthorn winter' comes about the same time; it is said that there are generally some warm days at the end of March or beginning of April which bring the blackthorn into bloom, after which comes a cold period called the 'blackthorn winter'.

Depletion of Nutrient Salts in the Sea

In NATURE of February 25 reference was made in this Calendar to the annual spring outburst of planktonic diatoms in the sea. The growing plants consume nutrient salts—phosphates, nitrogen compounds, silicate, and carbon dioxide—and their removal from solution in the water as the plants increase in abundance may be surprisingly rapid. In 1931, between March 23 and April 22, 81 per cent of the nitrate and 70 per cent of the silicate was removed from the sea in the vicinity of Plymouth. Indeed, chemical analysis of the sea-water affords the readiest means of following the diatom outburst. The annual production of phytoplankton in the whole of the English Channel has been calculated to be at least 115 million metric tons, of which the greater part is formed in a few weeks in the spring. In the Barents Sea the outburst occurs about a month later than in the English Channel. In low latitudes, sunlight is always sufficient to permit of plant growth and nutrient salts do not therefore accumulate sufficiently for a big spring outburst to take place. Where, however, upwelling currents bring nutrient salts from the rich reserves in the ocean depths—as off Cape Verde and along the coast of California—a rich plankton may flourish at other seasons.

Spring Outburst of Spawning in Mollusca

Although a few common British gastropods spawn in autumn and winter—notably *Patella*, *Littorina littorea*, *Buccinum*, *Purpura*, *Trivia arctica*, and certain of the Rissoidæ, by far the larger number breed in spring and summer. In March the marine plankton quite suddenly becomes full of all kinds of gastropod veligers, and eggs are laid in any suitable place. Some time during this month we should find the eggs of *Littorina obtusata* and *Lacuna vincta* laid on the seaweeds between tide marks, and just below low water the egg capsules of *Nassarius* on weeds and Bryozoa, and of turrids on anything available. The nests of *Lamellaria* and of *Trivia monacha* in compound ascidians on the shore are also to be found about this time. In March, too, *Aporrhais pes-pelicani* begins to lay its eggs singly in the sandy mud of the sea floor. These are only a few instances of the general rush of molluscs to begin breeding in this month. Many of them continue to lay all through the spring and summer as well.

In the plankton, an inshore haul in March is usually full of the free-swimming larvæ of *Nassarius*, *Rissoa*, and *Lacuna*. The beautiful little Echinospira larva of *Lamellaria* and *Trivia* with their accessory shells also abound. All these feed upon the microscopic plants and animals to be found at this time in the surface layers of the sea, especially diatoms. There can be no doubt, in fact, that larval molluscs devour a very large part of the annual spring crop of diatoms in our waters.

"The Sea-Blue Bird of March"

Although the kingfisher is traditionally associated with the Halcyon Days, the seven days before and after the winter solstice, a more natural association is with the present month. It is now that it is specially noticeable by the river, partly because March sunshine picks out its brilliance against sombre backgrounds, partly because its movements are still unobscured by foliage, and mainly because the mated birds are busy hunting for nesting sites. It was on March 19 that Mr. R. B. Rivière first noticed the digging of the nest-tunnel of the pair, the habits of which he has recently described (*British Birds*, Feb. 1933, p. 262). The tunnel was completed on March 21, both birds apparently sharing in the excavation, but it was then neglected until March 27, and was finally deserted for an old nesting hole nearby. Egg-laying began on April 27; the parents, sharing incubation, began to sit on May 3 or 4, and on May 23 the hen carried the first food to the nest for the young. The period of incubation therefore occupied about 20 days, and the development of the young, from hatching to flying, 27 days. It was noted that as the young grew they were fed upon larger and larger fish, and these were invariably presented to them head first, the position in which the adults themselves always swallowed their prey. Surely Shelley must have been taking full advantage of the poet's handicap when he described how "I saw two azure halcyons . . . thinning one bright bunch of amber berries."

Opening of the Nesting Season

Each season one species of bird or another, generally the starling, house-sparrow or wood-pigeon, endeavours to break the record of early nesting, but generally speaking, March may be said to mark the opening of the nesting season in Britain. Before the end of the month it might be possible to find the nests of about twenty-six different species, and thereafter with the influx of summer migrants the numbers steadily rise, so that almost a hundred kinds of nests may be found in April. In the latter half of May, nesting activity reaches its climax, and although June also is a favoured month, the numbers begin to show a decline which progresses rapidly through July and brings the normal nesting season to an end in August, when a persistent group of perhaps seven or eight species carry on the last of their series of clutches.

Distribution of Manure

At least one and a quarter million tons of chemical manures are used in Great Britain every year, and by far the greater part of this is applied between mid March and mid May. The actual method of distribution is a matter of some importance, for uneven spreading may involve the crop in local starvation or poisoning as the case may be. Moreover, these irregularities when once established are not readily rectified. Much thought has been given to the construction of manure drills, and

comprehensive tests have been conducted from time to time to test the various machines in respect of uniformity of distribution over the surface of the ground. In practice, the drill is usually followed by some cultivating implement the function of which is to mix the fertiliser with the soil so that depth distribution as well as surface distribution is in question.

Until recently, the degree of mixing attained by the various classes of implements was only a matter of conjecture, but an ingenious method has now been devised in Germany to render the particles of manure in the soil directly visible, thus enabling depth distribution studies to be undertaken in soil samples carefully removed from the field. The fertiliser is treated with anthracene before sowing, and after distribution and cultivation the samples are examined in ultra-violet light. By this means it has been found that the newer rotary cultivation gives a more uniform distribution than either the surface working implements or the plough. The extent to which these differences of location of the fertiliser affect the crop has not yet been extensively investigated, although on general grounds thorough incorporation would seem to be desirable, particularly with relatively insoluble manures.

Societies and Academies

LONDON

Royal Society, March 9. J. H. AWBERY and E. GRIFFITHS: The heats of combustion of carbon monoxide in oxygen and of nitrous oxide in carbon monoxide at constant pressure. The heat of combustion of carbon monoxide in oxygen is 282,730 joules per mole at 20° C., correct to within 3 parts in 1,000. The heat of reaction when nitrous oxide burns in carbon monoxide is 364,340 joules per mole, correct to 2 or 3 parts in 1,000. From these two results, the heat of formation of nitrogen dioxide at constant atmospheric pressure and at a temperature of 20° C. is found to be 81,610 joules, that is, 19·50 $cal._{15°}$ per mole. This quantity is determined as the difference between two heats of combustion, which were carried out with the same apparatus used in the same manner for both sets of experiments. R. W. FENNING and F. T. COTTON: A bomb calorimeter determination of the heats of formation of nitrous oxide and carbon dioxide. By means of a bomb calorimeter the heats of reaction of oxygen and nitrous oxide in carbon monoxide and hydrogen respectively were measured. Thus, by difference, two values were obtained for the heat of formation of nitrous oxide. A value for the heat of formation of carbon dioxide from carbon monoxide and oxygen was also obtained. Since the combustion of oxygen in hydrogen formed the calibration process, all the values given are based on the acceptance of 68,320 gm. $cal._{15°}$ as the heat of formation of water (liquid) at constant pressure and at 25° C. On this basis, the heats of formation of nitrous oxide and carbon dioxide at a constant pressure of 1 atmosphere and at 20° C. were found to be—19·74 ± 0·07 $kcal._{15°}$, or 82,600 ± 290 international joules, and $67·65_5 \pm 0·03_5 kcal._{15°}$, or 283,090 ± 150 international joules respectively. A. H. HUGHES and E. K. RIDEAL: On the rate of oxidation of monolayers of unsaturated fatty acids. The method of surface potentials has been employed to study chemical reactions occurring in a unimolecular film; the reactions examined being the oxidation by acidified potassium permanganate of long chain unsaturated aliphatic acids such as oleic acid. The reaction velocity depends on the accessibility of the double bond to the oxidising agent, and decreases markedly on compression of the film. Reaction velocity has been studied as influenced by the position of the double bond in relation to the polar carboxyl headgroup. Autoxidation in a unimolecular film has been observed for the elæostearic acids, and the effect of hydroquinone as an antioxygen to this reaction has been examined.

EDINBURGH

Royal Society, Feb. 6. F. A. E. CREW: A case of non-disjunction in the fowl. An exceptional gold cock, *ex* Light Sussex × Rhode Island Red, when mated to Light Sussex females produced 66 silver males, 2 silver females, 48 gold females and 1 gold male. Cytological examination detected trisomic diploid silver males amongst the progeny. The number of the small autosomes is variable, and the small *Y* could not be distinguished from these. It was not possible, therefore, to identify any other cytologically exceptional types. The genetical and cytological evidence warrants the conclusion that this exceptional cock is an instance of secondary non-disjunction of the sex-chromosomes. A. C. STEPHEN: Studies on the Scottish marine fauna—the natural faunistic divisions of the North Sea as shown by the quantitative distribution of the Mollusca. By the changes in the density and identity of the dominant species of molluscs, especially lamellibranchs, the North Sea within the 100 fathom line may be divided into four zones: (*a*) littoral zone extending to about 2 fathoms; (*b*) coastal zone extending to about 20 fathoms in Scottish waters but covering the southern North Sea with the 30 fathom line which lies to the north of the Dogger Bank; (*c*) offshore zone covering much of the remaining area; (*d*) Thyasira and Foraminifera zone occupying a small area in the north-eastern North Sea near the Norwegian Deep. Communities are regarded as special cases of zoning. A. CRICHTON MITCHELL: Diurnal incidence of disturbance in the terrestrial magnetic field. By using as a measure of activity, $(Xr_X + Yr_Y + Zr_Z)/1{,}000$, where X, Y, Z are the force components and r_X, etc., are hourly ranges, it is shown from the records of Eskdalemuir Observatory for 1914–25, that diurnal distributions of activity in the field can be represented as a mixture of two different types. One of these is due to ionisation in an upper layer of the atmosphere, 213 km. high, and is produced by the action of ultra-violet light from the sun. It varies in its time of on-set with the varying time of sunrise at that height. The second is due to ionisation in the Heaviside layer, about 90 km. high, produced by corpuscular streams from the sun. It has a maximum at 10.30 p.m. and does not alter in phase with the season of the year. The height of the upper ionised layer was found to have a seasonal variation of type very similar to that of the amplitude in the second term of the harmonic series representing the diurnal variation of pressure. LOUIS HERRMAN and LANCELOT HOGBEN: The intellectual resemblance of twins. The intelligence-quotients of four hundred twin pairs have been determined. The separation of like sex pairs into identical and fraternal classes has been made with the assistance of Stocks's finger-print

diagnosis. The correlation coefficients corrected for attenuation by Spearman's formula were found to be: identical pairs, $0{\cdot}86 \pm 0{\cdot}04$; fraternal twins of like sex, $0{\cdot}48 \pm 0{\cdot}08$; fraternal twins of unlike sex, $0{\cdot}53 \pm 0{\cdot}06$. The mean differences for fraternal and identical pairs are in the ratio 2 : 1 in accordance with previous observations by Holzinger and by Tallman. The contribution of genetic differences to the distribution of intelligence within the family is discussed. Sib correlations in this investigation were found to be significantly lower (0·37) than correlations for fraternal twins. Other data also point to the significance of birth rank in determining differences of *I.Q.* CH. KOLLER and THELMA TOWNSON: Spermatogenesis in *Drosophila obscura*, Fallen. (1) The cytological basis of suppression of crossing-over. Homologous chromosomes associate in pairs during metaphase and anaphase of the spermatogonial division, and this association sometimes results in a fusion of their ends. They enter into prophase of the first meiotic division with their ends already associated. The *X* and *Y* associate at one end, and this association persists through prophase of the first meiotic division.

PARIS

Academy of Sciences, Feb. 6 (*C.R.*, 196, 377–447). The president announced the death of M. Mesnager. J. COSTANTIN: Objections to the mycorrhizal theory. Discussion of objections raised to the author's theory of the cause of resistance of sugar-cane to disease produced by altitude. GEORGES DURAND: The stability of rows of vortices. Y. LAURE: The combustion pressures in closed vessels of air–benzene mixtures. An account of experiments on the explosion pressures developed in a sphere and three cylinders of different ratios of height to diameter. For a fixed ratio of surface to volume the results differ according to the bomb employed: varying the ratio of surface to volume by the introduction of thin metal sheets is unsatisfactory since the results depend on the position of the sheets. V. DOLEJŠEK and MLLE. E. FILČAKOVA: The *M* series of tantalum obtained by means of an ionic tube. ROBERT FERBER: A purely photographic method for the orthogonal projection on a horizontal plane of topographical plans. R. TITÉICA: Vibrational spectra and the structure of the molecules of methyl and ethyl alcohols. Measurements of the infra-red spectra of the vapours. P. LE ROUX: Study of the pleochroism of Iceland spar in the infra-red spectrum. For the specimens of Iceland spar studied, in the infra-red region between 2·2 μ and 4·4 μ, as soon as the absorption becomes large, it is impossible to admit that it is independent of the direction of propagation of the light. Q. MAJORANA: The action of a periodic light beam on metallic sheets. The conclusions given in an earlier note on the same subject, while in part confirmed, require modification. MME. IRÈNE CURIE and F. JOLIOT: The conditions of emission of neutrons by the action of α-particles on the light elements. The elements studied were beryllium, boron, lithium, aluminium and fluorine. The nuclei Al^{27} and F^{19} undergo two different modes of transmutation, one with the emission of protons, the other with emission of neutrons. Such a case has not hitherto been observed, since for boron the neutron emission is attributed to B^{11} and that of protons to B^{10}. R. LESPIEAU and MLLE. B. GREDY: The study of some α-ethylene oxides. A comparison of the Raman spectra for ethylene oxide and some of its derivatives. The characteristic frequency of the ethylene oxide nucleus is about 1,250, which is common to all the spectra. A. LALANDE: The freezing points of binary mixtures of ethyl alcohol and ethyl ether. The curve showing the freezing point as a function of the composition has two branches: one corresponds to the separation of solid alcohol, the other probably to a separation of pure ether. No stable molecular complex is indicated. H. MURAOUR and G. AUNIS: The laws of combustion of colloidal powders. A. GIRARD and G. CHAUDRON: The dissociation of cubic ferric oxide. In microcrystalline mixtures of artificial or natural oxides of iron, X-ray analysis is powerless to detect the presence of the cubic variety: the dissociation curves give more information. P. DEMOUGIN: The solubility of gun-cottons. G. RUMEAU: Optical antipodes and crystallisation velocities. The non-existence of racemic substances in the liquid state. GEORGES FOURNIER and MARCEL GUILLOT: The relation between the absorption of β-rays by organic compounds and the molecular structure of the latter. The results of experiments described show that the deviation between the observed and calculated coefficients of absorption are in direct relation with the chemical constitution of the molecule, especially with the nature of the linkages between the atoms of carbon B. BOGITCH: The reduction and oxidation of the manganese silicates. MLLE. CAILLÈRE: A fibrous sepiolite from Madagascar. DINCA SAMUIACAS: The influence of the X-rays on the formation of the crystalline germ. C. L. ALEXANIAN: The establishment of the map of anomalies of the vertical component of the earth's magnetic field in the plain of Alsace. M. CHADEFAUD: The existence of an oriented infra-visible structure of the cytoplasm in Algæ. A. MAIGE: The physico-chemical heterogeneity of plasts. LOUIS GALLIEN: The histological transformations correlative with the sexual cycle in *Polystomum integerrimum*. MME. FRANÇOISE BLOCH: Fecondation and maturation of the egg in *Diogenes pugilator*. ETIENNE WOLFF: The topography of first rudiments of the liver, from the study of omphalocephalous fowls. MAURICE LECAMP: Transplantations of rudiments of the posterior limbs in *Alytes obstetricans*. TH. KOFMAN: The diffusion by the human skin of visible and ultra-violet radiations. A. DOGNON: The action of monochromatic X-rays of varying wavelength on the egg of *Ascaris*. M. MASCRÉ and R. PARIS: The action of formol on emulsin and invertin. H. BURGEVIN: The fixation of atmospheric nitrogen by the bacteria of the Leguminoseæ. A. J. KLUYVER and J. C. HOOGERHEIDE: The influence of oxygen on alcoholic fermentation.

CRACOW

Polish Academy of Science and Letters, Nov. 7. O. NIKODYM: Remarks on a note of N. Nikliborc concerning completely integrable systems of total differential equations. S. KACZMARZ: The homeomorphy of certain spaces. S. MAZURKIEWICZ and MLLE. H. SZMUSZKOWICZONA: Suites of polynomials. S. DOBINSKI: The dielectric constant of liquid phosphorus. The data found show that liquid phosphorus contains no dipoles. From a discontinuity in the dielectric constant at 48·6°C., it would appear that liquid phosphorus exists in the form of two distinct modifications. K. DZIEWONSKI, W. KAHL, MLLE. W. KOCZOROWSKA and M. A. WULFFSOHN:

Syntheses of 4·4-diacenaphthylmethane, of 4·4-diacenaphthylketone and their oxidation derivatives. ST. KREUTZ: The vicinal faces of topaz. J. S. RUSZKOWSKI: Studies on the evolutive cycle and on the structure of marine cestodes. The evolutive cycle of *Grillotia erinaceus*. J. WALAS: The plant associations of 'Babia Góra'.

Dec. 5. ST. BANACH: Lacunar series. J. SCHREIER: The plane sections of non-convex surfaces. M. JEZEWSKI: Application of the resonance method to the determination of the dielectric constants of aqueous electrolytes. The method of resonance is liable to numerous errors. The author analyses these sources of error and shows how they can be eliminated. K. DZIEWONSKI, MLLE. M. DOMINIKOWNA, L. GALUSZKOWNA and WL. MUZ: Studies in the fluorene series. Syntheses of hydrocarbons and ketones derived from 2-benzylfluorene and 2-benzoylfluorene. WL. SZAFER: A case of anomalous anatomical structure of a pine (*Pinus sylvestris*). F. ROGAZINSKI and Z. GLOWCZYNSKI: Experimental rickets. Rickets and weakness of the limbs in chicks. A. MOSZYNSKI: Description of a new species of oligochæte, *Fridericia Stephensoni*.

Forthcoming Events

Saturday, March 25

ROYAL INSTITUTION, at 3.—Developments in Cinematography: A Display of Films, (2) Colour Films.

Monday, March 27

BRITISH SCIENCE GUILD, at 2.30.—Symposium on "The Utilization of Coal". Speakers: Capt. B. Acworth, S. Lacey, Rear-Admiral W. Scott Hill and A. C. Hardy.

ROYAL GEOGRAPHICAL SOCIETY, at 5.30.—The Mount Everest Film of 1922 (Climbing Sections): also an early film on Borneo by Carl Lumholz.

Tuesday, March 28

ROYAL AERONAUTICAL SOCIETY, at 6.30.—Annual General Meeting.

Wednesday, March 29

CHEMICAL SOCIETY, at 5.30.—(Faraday Lecture at the Royal Institution, Albemarle Street, W.1).—Prof. P. Debye: "The Relations between Stereochemistry and Physics".

Thursday, March 30

CHEMICAL SOCIETY, at 4.—Annual General Meeting. Presidential Address: "The Present Position and the Future of the Chemical Society".

Friday, March 31

ROYAL ASTRONOMICAL SOCIETY, at 4.30.—Geophysical discussion on "Wave Patterns" to be opened by Sir Gilbert Walker, followed by Dr. Rosenhead, Dr. Vaughan Cornish and Dr. Harold Jeffreys.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.—(Informal Meeting: Lantern Lecture.)—L. Ennis: "The Sydney Harbour Bridge".

ROYAL INSTITUTION, at 9.—Sir Frederick Keeble: "The Nitrogen Hunger of the World".

Saturday, April 1

ROYAL INSTITUTION, at 3.—Developments in Cinematography: A Display of Films, (3) Films in Relation to Aeronautical Research.

Official Publications Received

GREAT BRITAIN AND IRELAND

National Laboratory of Psychical Research. Bulletin 4: An Account of some Further Experiments with Rudi Schneider; a Minute-by-Minute Record of 27 Séances. By Harry Price. Pp. 199+23 plates. (London: National Laboratory of Psychical Research.) 10*s*. net.

The National Institute of Agricultural Botany. Thirteenth Report and Accounts, 1931–32. Pp. 20. (Cambridge.)

The Economic Proceedings of the Royal Dublin Society. Vol. 2, No. 31: Grass Silage. By C. Boyle and J. J. Ryan. Pp. 515–528. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6*d*.

Proceedings of the Liverpool Geological Society, Session the Seventy-third, 1931–1932. Edited by D. A. Allan. Part 1, Vol. 16. Pp. xii+61. (Liverpool.)

Journal of the Royal Statistical Society. Vol. 96, Part 1. Pp. viii+182. (London: Royal Statistical Society.) 7*s*. 6*d*.

Navy (Health). Statistical Report of the Health of the Navy for the Year 1931. Pp. 148. (London: H.M. Stationery Office.) 2*s*. 6*d*. net.

The Quarterly Journal of the Geological Society of London. Vol. 89, Part 1, No. 353, February 28th. Pp. 86. (London: Longmans, Green and Co., Ltd.) 7*s*. 6*d*.

Economic Advisory Council. Severn Barrage Committee Report. Pp. 28. (London: H.M. Stationery Office.) 6*d*. net.

OTHER COUNTRIES

Annual Report of the Indian Central Cotton Committee, Bombay, for the Year ending August 31, 1932. Pp. ii+136. (Bombay.) 2 rupees.

The Indian Lac Research Institute. Bulletin No. 12: Shellac Drying Oil Combinations. By Dr. R. W. Aldis. Pp. 4. (Nankum, Ranchi.) 1.8 rupees.

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 90: On the Flow of Water through Tubes. By Daizo Nukiyama. Pp. 233–290+6 plates. 65 sen. No. 91: A New Method of Thickness-Measurement of Metal Films. By Sin Tanaka. Pp. 291–306+plates 7–9. 25 sen. (Tôkyô: Koseikai Publishing House.)

Asiatic Society of Bengal. Annual Report for 1932. Pp. 34. (Calcutta: Asiatic Society of Bengal.)

Department of Agriculture, Sierra Leone. Soil Survey of Sierra Leone. By Dr. F. J. Martin and H. C. Doyne. Pp. 35. (Njala.)

Koninklijk Nederlandsch Meteorologisch Institut. No. 106A: Ergebnisse Aerologischer Beobachtungen. 20, 1931. Pp. iv+42. 2.50 f. No. 108: Seismische Registrierungen in De Bilt. 18, 1930. Pp. vii+66. 1.00 f. (De Bilt.)

Bernice P. Bishop Museum. Bulletin 95: Kepelino's Traditions of Hawaii. Edited by Martha Warren Beckwith. Pp. 206. Bulletin 96: Geology of Eua, Tonga. By J. Edward Hoffmeister; includes Petrography, by Harold L. Alling; Foraminifera, by G. Leslie Whipple. Pp. 93+22 plates. Bulletin 97: Sexually Mature Larval Hemiramphidæ from the Hawaiian Islands. By Otto Schindler. Pp. 28+10 plates. Pacific Entomological Survey, Publication 1: Marquesan Insects, 1. Pp. iv+244. (Honolulu.)

Union of South Africa: Fisheries and Marine Biological Survey. Reports Nos. 8 and 9 for the Period July 1929–December 1931. By Dr. Cecil von Bonde. Pp. 28+42+30+128+34 plates. (Pretoria: Government Printer.)

Union of South Africa: Department of Agriculture. Science Bulletin No. 110: Soil Fertility Problems in Natal. By C. O. Williams. (Chemistry Series No. 124.) Pp. 39. (Pretoria: Government Printer.) 3*d*.

Ibero-Americana 4: A Spanish-Mexican Peasant Community, Arandas in Jalisco, Mexico. By Paul S. Taylor. Pp. vi+94 (8 plates). (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 1.50 dollars.

Science Reports of the Tokyo Bunrika Daigaku, Section A. No. 22: Cryoscopic Studies on the Transition Points of the Compounds of Organic Solvents with Salts, 2. By Hazime Oosaka. Pp. 241–249. 15 sen. No. 23: A Theory of the Spin of Electron. By Seisaku Shimasaki. Pp. 251–273. 30 sen. (Tokyo: Maruzen Co., Ltd.)

Instituts scientifiques de Buitenzorg: "'s Lands Plantentuin". Treubia: recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 14, Livraison 1, Decembre. Pp. 152. (Buitenzorg: Archipel Drukkerij.)

Collection des travaux chimiques de Tchécoslovaquie. Rédigée et publiée par E. Votoček et J. Heyrovský. Année 5, No. 2, Février. Pp. 49–92. (Prague: Regia Societas Scientiarum Bohemica.)

U.S. Department of Agriculture. Circular No. 255: Observations on the Mexican Fruit Fly and some related Species in Cuernavaca, Mexico, in 1928 and 1929. By M. McPhail and C. I. Bliss. Pp. 24. (Washington, D.C.: Government Printing Office.) 5 cents.

Bulletin of the American Museum of Natural History. Vol. 59, Art. 9: New Remains of Trilophodont-Tetrabelodont Mastodons. By Childs Frick. Pp. 505–652. (New York City.)

U.S. Department of Commerce: Bureau of Standards. Handbook No. 17: Code for Protection against Lightning, Parts 1, 2 and 3. Pp. x+93+2 plates. 15 cents. Research Paper No. 502: Characteristic Equations of Vacuum and Gas-filled Tungsten-Filament Lamps. By L. E. Barbrow and J. Franklin Meyer. Pp. 721–732. 5 cents. (Washington, D.C.: Government Printing Office.)

Bulletin of the Bingham Oceanographic Collection. Vol. 3, Art. 5: Scientific Results of the Third Oceanographic Expedition of the *Pawnee*, 1927—Deep Sea Eels, exclusive of Larval Forms. By Albert Eide Parr. Pp. 41. Vol. 4, Art. 3: A Geographic-Ecological Analysis of the Seasonal Changes in Temperature Conditions in Shallow Water along the Atlantic Coast of the United States. By A. E. Parr. Pp. 90. Vol. 4, Art. 4: A Contribution to the Study of the Natural Food-Cycle in Aquatic Environments; with particular consideration of Micro-Organisms and Dissolved Organic Matter. By Richmond M. Bond. Pp. 89. (New Haven, Conn.: Yale University.)